SYSTRON DONNER
Member THORN EMI Group

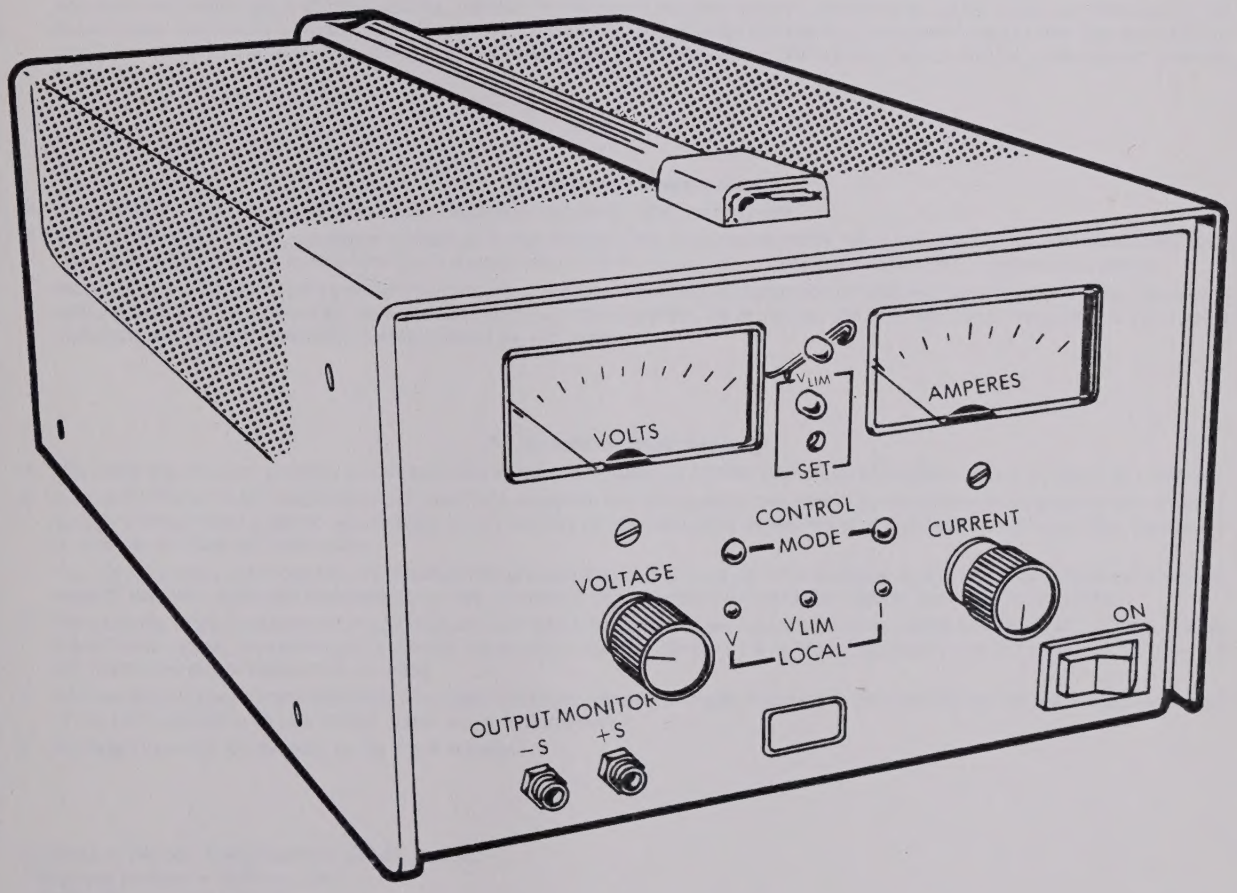
PHR

INSTRUMENT DIVISION

POWER SUPPLIES

DOCUMENT NO. 120006-01

OPERATING AND SERVICE MANUAL



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The Test & Measurement Group of Systron Donner warrants that at the time of shipment the products manufactured by Systron Donner's T & M Group and sold hereunder will be free from defects in material and workmanship and will conform to the specifications furnished by or approved in writing by Systron Donner's T & M Group.

II Warranty

A **The warranty period for products published in our latest product catalog will be one year from the date of shipment. This warranty is extended only to the original buyer.**

B The warranty period for products published in prior catalog, will be 90 days from the date of shipment.

C The warranty period for modified standard products, custom products, or new spare part assemblies will be 90 days from the date of shipment.

D The warranty period for systems or assemblies of miscellaneous components and products will be limited to the warranty for the stand alone component or instrument. The system itself is not guaranteed unless a specific installation and service agreement has been negotiated between Systron Donner and the customer. In this latter case, the warranty period will be 30 days after the installation of the system while the various portions of the system will be limited to the normal component or instrument stand alone warranty, and for non Systron Donner material within the system that is furnished by Systron Donner the warranty will be limited to the supplier's normal warranty.

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A If any defect within this warranty appears, Purchaser shall notify Seller immediately.

B Systron Donner's T & M Group agrees to repair or furnish a replacement for, but not install, any product which, within the standard warranty shall, upon test and examination by Systron Donner's T & M Group, prove defective within the above warranty period.

C No product will be accepted for return or replacement without the written authorization of Systron Donner's T & M Group. Upon such authorization and in accordance with instructions by Systron Donner's T & M Group, the product will be returned to the original manufacturing location, shipping charges prepaid by Purchaser.

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E This warranty applies to new equipment only and will cover repaired or replacement items only to the extent of the balance remaining of the items original warranty period noted above in Paragraph II.

F All freight charges will be paid for by the Purchaser.

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January 1982

SYSTRON DONNER
Member THORN EMI Group

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* Indicates all ECO/amendment numbers which are included in this manual.

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CHAPTER 1

GENERAL INFORMATION

1-1. INTRODUCTION

1-2. The PHR-Series power supplies consist of three half-rack supplies. These supplies may be operated locally via the front panel controls or switch selected for remote operation using a remote program source. The Systron Donner P-1 and P-2 Programmer modules provide all the logic necessary to control the PHR-Series supplies via an IEEE Std 488 GPIB.

1-3. Table 1-1 provides a listing of the three models that make up the PHR-Series power supply system. This instruction manual contains the general characteristics and specifications, operating procedures, principles of operation, maintenance and calibration procedures, parts lists and the related schematic diagrams and assembly drawings for all the modules that comprise the PHR-Series power supplies.

1-4. The P1, P1E, and P2 Programmer modules that provide the remote programming for the power supplies are not included in this instruction manual. If the power supplies are to be system configured, utilizing programmer modules refer to the P1 and P2 Programmer Instruction Manual for detailed information on system configuration, programmer data and operation and maintenance of the Programmer modules.

1-5. DESCRIPTION

1-6. The PHR-Series power supplies are modular in design to allow a compact multiple output programmable system configuration for use in test and process-control systems when used in conjunction with the P-Series programmer(s). The programmer will allow up to eight power supplies to be controlled via a General Purpose Interface Bus (GPIB) which conforms to IEEE Std 488-1978 or locally via the programmer front panel data switches. The power supplies will respond to program changes in less than 2 milliseconds. Each power supply module may be controlled locally by its front panel control settings when the local modes are selected on the rear panel switch. The PHR power supply modules are compact, precision, dissipative regulators housed in half rack chassis having equal height and depth, thus allowing a compact multiple output rack assembly. Both constant voltage and constant current operation is provided, which may be either locally controlled or remotely programmed. In the voltage mode, adjustable current limiting is provided, while the current mode provides adjustable voltage limiting. Both output voltage and current are front panel metered, and front panel indicators provide indication of the operational mode of the supply.

Table 1-1. PHR-Series Models

Model	Function and Characteristics
PHR 20-12	Programmable 0-20 V, 0-12 A, half-rack power supply
PHR 50-8	Programmable 0-50 V, 0-8 A, half-rack power supply
PHR 100-4	Programmable 0-100 V, 0-4 A, half-rack power supply

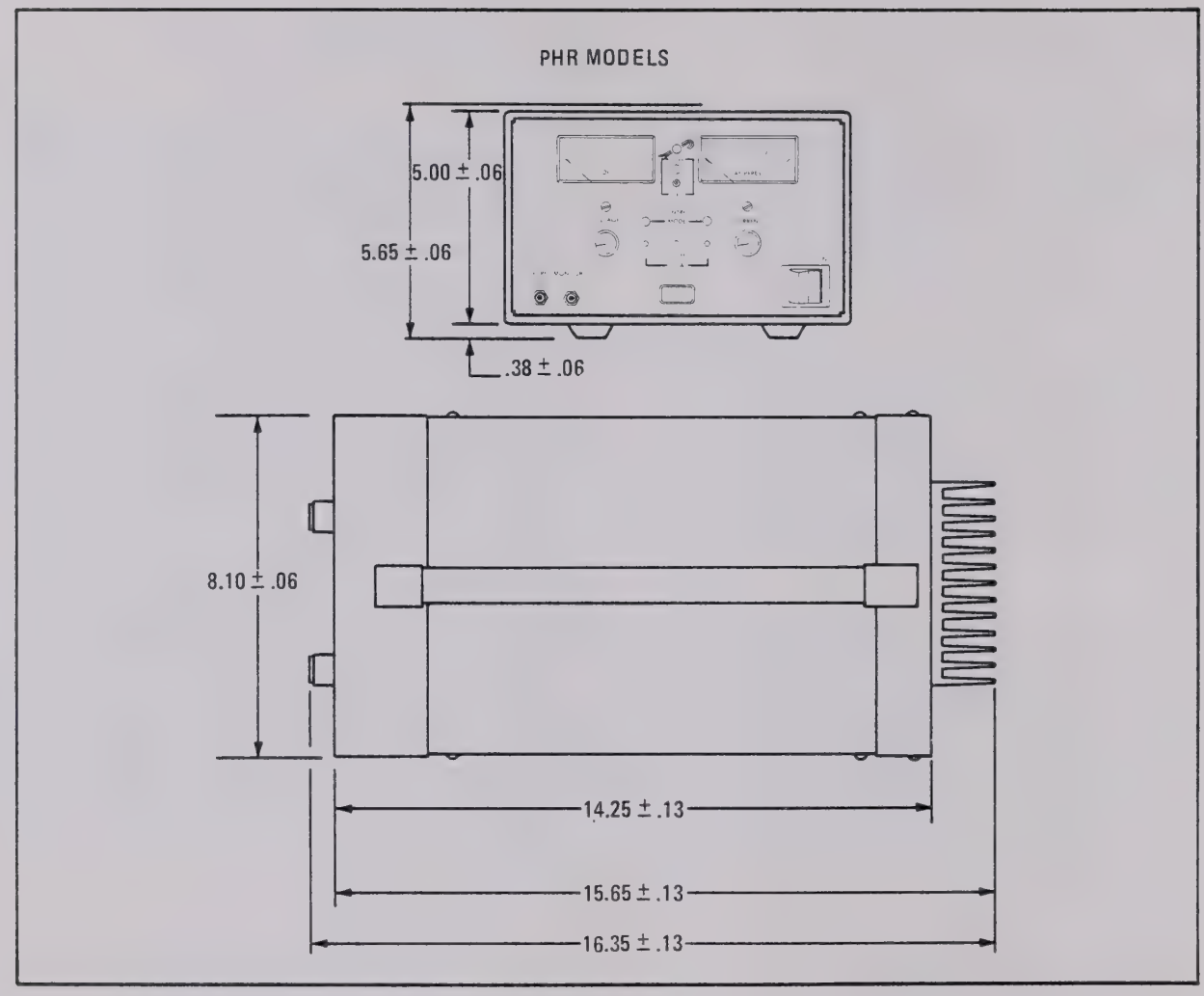


Figure 1-1. PHR—Series Outline Drawing

1-7. SPECIFICATIONS

1-8. Table 1-2 lists the power supply power ratings. The performance specifications describe the power supply's warranted performance and are listed in Table 1-3. Table 1-4 provides the supplemental characteristics of the power supply which are typical values, but non-warranted performance parameters.

1-9. PHYSICAL CHARACTERISTICS

1-10. Table 1-5 lists the PHR-Series power supply's physical characteristics. Figure 1-1 provides outline drawings with dimensional data.

Table 1-2. Power Ratings

Model	Output				Sink Current Limit [3]	Input 100 to 130 Vac, 47 to 63 Hz		
	Voltage Mode [2]		Current Mode					
	Range [1]	Resistance	Range	Impedance		Current [4]	Watts	Efficiency
PHR 20-12	0-20 Vdc	16 μΩ	0 to 12 A	6.7 kΩ + 16 μF	2.5 A	6.0 A	400	60%
PHR 50-8	0-50 Vdc	63 μΩ	0 to 8 A	16.7 kΩ + 10 μF	1.5 A	8.5 A	600	66%
PHR 100-4	0-100 Vdc	250 μΩ	0 to 4 A	33.3 kΩ + 5 μF	0.4 A	8.0 A	550	72%

NOTES:

1. An extra 0.5 V per output lead compensates for lead voltage drop.
2. Isolation voltage: 400 V terminal to chassis.
3. Nominal value.
4. When wired for 230 V ac operation, current will be one-half value.

Table 1-3. Performance Specifications

Parameter	Stabilization Mode Voltage	Stabilization Mode Current
LOAD EFFECT: The change in stabilized output caused by a load change equal to the output rating.	0.001% E-rated	less than +3 mA
SOURCE EFFECT: The change in stabilized output caused by any change in the ac line within the input rating.	0.001% E-rated	0.005% I-rated
PARD: Periodic and random deviations from the stabilized output, measured from 20 Hz to 4 MHz.	1 mV rms 0.02% E-rated, p-p	0.05% I-rated, rms .25% I-rated, p-p
STEP RESPONSE TIME: The time required to achieve stabilization within		

Parameter	Stabilization Mode Voltage	Stabilization Mode Current
0.1% of full scale into a resistance load for a program change of:		
a) 90 to 100% of full load.	less than 2 ms	less than 1 ms
b) 10 to 100% of full load.		
Up	60 ms	60 ms
Down	2 ms	2 ms

With a capacitive load, voltage stabilization may be delayed because current, charge or discharge, is limited. When the load capacitance is known, the step response time can be calculated using the equation below. C_i is the supply's internal capacitor (see output ratings) and I_1 is the sink or source current limit. The units of measure are seconds, volts, farads, and amps.

$$\text{Response Time} = \frac{E\,(C_i + C_e)}{I_1}$$

Table 1-4. Supplemental Characteristics

Parameter	Stabilization Mode Voltage	Current
DRIFT: The output drift over 8 hours under constant line, load and temperature after a 30-minute warmup, under load.	Local: 0.01% Remote: 0.005%	0.25%
TEMPERATURE EFFECT: The change in stabilized output per °C change in ambient temperature	Local: 0.01% Remote: 0.005%	Local: 0.02% Remote: 0.02%
ADJUSTMENT RANGE: The output range obtainable with front panel controls.	0 to 100%	0 to 100%
RESOLUTION: The resolution obtainable with front panel controls.	0.03%	0.04%
PROGRAMMING SCALE: The external input that will change the output. from min. to max.	0 to +10 V @ 1 mA Voltage and V_{LIM}	0 to −1 mA @ −1 V

Parameter	Stabilization Mode Voltage	Current
TRANSIENT RECOVERY: Time required to recover within 0.1% E-rated following a step load change between 10% and 100% of I-rated.	50 μs	
METER ACCURACY: The max. nonlinear error @ 25°C.	2%	
V_{LIM} ADJUSTMENT RANGE	1 to 110%	
V_{LIM} MARGIN: The recommended min. margin of setting above output voltage.	5%	
USEFUL CROWBAR RANGE	5 V to 110%	
CROWBAR THRESHOLD: The voltage above V_{LIM} at which the crowbar will trip.	1 % (50 μs response)	

NOTES:

All percentages are full scale (rated) value.

Table 1-5. Physical Characteristics

STORAGE TEMPERATURE −40 to +85°C

OPERATING TEMPERATURE 0 to +55°C

DIMENSIONS
(H) 5.65 in (143.5 mm)
(W) 8.31 in (211.1 mm)
(D) 16.35 in (415.3 mm)

WEIGHT
Net – 33 lbs (15 kg)
Ship – 40 lbs (18 kg)

CHAPTER 2

INSTALLATION AND OPERATIONS

2-1. INTRODUCTION

2-2. The PHR-Series power supplies are shipped in operational condition and are ready for use as received. This chapter outlines the procedures for initial inspection, installation and operation of the unit. Instructions for reshipment are also included should the unit be returned to Systron Donner for service or repair.

2-3. RECEIVING INSPECTION

2-4. Prior to accepting the unit from the shipper, inspect the condition of the shipping container for any indication of freight damage. Any sign of such damage must be noted by both the shipper and receiver and should be reported to the insurance investigator.

2-5. Immediately following removal of the instrument from the shipping carton, inspect for possible physical damage incurred during shipment. Check surfaces for scratches or dents and note condition of controls and connectors. Should any damage be noted, notify your nearest Systron Donner representative --- DO NOT USE THE POWER SUPPLY UNTIL INSTRUCTED TO DO SO BY THE REPRESENTATIVE.

2-6. RESHIPMENT

2-7. When the instrument is to be repackaged for shipment use the original packing materials. Your Systron Donner representative can provide materials similar to those used for the original factory packaging, or repackage the instrument following these general instructions.

General packaging instructions:

1) Attach a tag to the unit indicating the model number, serial number, name and address of the instrument owner, and a summary of the service or repairs required.

2) Wrap the instrument in heavy paper or plastic prior to placing it into the shipping container.

3) Select a strong carton or wooden box to house the instrument.

4) Use an adequate layer of shock-absorbing material on all sides of the instrument and protect the front panel with additional layers of cardboard. Be certain that there is no movement of the unit within the container.

5) Seal the package with strong tape or metal bands.

6) Mark the shipping container "FRAGILE-DELICATE INSTRUMENT" to ensure careful handling.

7) Be certain that all correspondence refers to full instrument nomenclature (model and serial number).

2-8. INSTALLATION

2-9. The PHR-Series power supply may be used as a stand-alone bench supply installed in its instrument cabinet, or rack mounted in groups to form compact multiple output rack assemblies. Rack mounting assemblies are provided by Systron Donner.

2-10. POWER REQUIREMENTS

2-11. The PHR-Series power supplies are equipped with a standard captive three-conductor power cord which when plugged into an appropriate power receptacle, grounds the power supply module to protect operating personnel from certain electrical hazards. Whenever the power cord is mated to a two-conductor outlet, a cord adapter plug (properly installed) will provide the same protection.

2-12. The instrument operates from an ac power source and by appropriate connection of internal taps from either 100 to 130 V ac, or 200 to 260 V ac at 47 to 63 Hz. Power consumption varies for each model as described in the specifications. Unless requested otherwise, the instrument is normally factory wired for 100 to 130 V ac. Prior to operation ensure the unit is wired for the correct line voltage application. To change operating voltages remove the connections to

T101 and T102 and rewire in accordance with the transformer connections depicted on the schematic diagrams following Chapter 5 and listed in Table 2-1.

Table 2-1. Power Transformer Primary Connections

Line Voltage	T101 Jumpers	T102 Jumpers
100/130	W2, W3	W4, W5
200/260	W1	W6

2-13. A heavy duty 3-wire line cord with molded NEMA style 5-15P plug provides input power. The power handling ability of the ac lines feeding ac power to the line cord must be considered, as serious losses in regulation and sustantial increases in ripple can occur as a consequence of insufficient power handling capacity of these lines. The ac impedance from the breaker box to the power supply input connector should not exceed 0.25 ohms. All ac power line connections must be securely tightened, and any movable electric contact surface (such as the wiper arm of a variable transformer) should be kept clear of impedance producing oxide coatings.

2-14. OUTPUT CONNECTION.

2-15. Output voltage is available at the rear panel terminal barrier strip TB101. The power supply is shipped from the factory with shorting links connected across the +V and +S and the −V and −S terminals to allow local sensing and regulation. The shorting links may be removed and sense leads connect to the load to allow remote sensing, noting however, that a voltage drop of 0.5 V per power lead must not be exceeded.

NOTE

If the sense leads are not connected to the load or the power supply output terminals, rated regulation cannot be maintained. The power supply must be operated with the sense leads connected, however, built-in circuitry will protect the power supply from damage should a sense lead or shorting link open.

2-16. The rear panel barrier strip TB101 is provided with a ground terminal. Either side of the output (+V or −V) may be grounded, or the output may be used in a floating condition, providing that the load circuitry is ≤ 400 V as referenced to earth ground.

2-17. FRONT PANEL.

2-18. The controls, indicators, meters and test jacks located on the front panel of the power supply are described in Table 2-2. Figure 2-1 depicts these locations by index number.

2-19. REAR PANEL.

2-20. The connectors and switches located on, or accessible via the rear panel of the power supply are described in Table 2-3. Figure 2-2 depicts their location by index number. Pin designations for the rear panel accessed 20-pin programming connector are provided in Table 2-4.

2-21. OPERATION.

2-22. The operation of the power supply may be controlled locally or programmed remotely as to its output voltage, current limiting or V_{LIM} set point. Ascertain which functions are to be controlled locally or programmed remotely and position the rear panel accessed V, I and V_{LIM} switches to their REMOTE (up) or LOCAL (down) positions.

2-23. Ascertain if local or remote sensing is to be used. If local sensing is to be used, ensure that the shorting links are installed between the +V and +S and the −V and −S terminals on the rear panel barrier strip. If remote sensing is to be used, open the shorting links between the +V and +S and −V and −S terminals. Connect sense leads between the +S and −S terminals and the load. If long sensing leads are required they should be a shielded twisted pair, with the shield grounded at the power supply and the load end left open. Either side of the output may be grounded or the output may be used in a floating condition. Ensure that the power leads connecting the +V and −V terminals to the load are of sufficient gage to carry the maximum current rating of the power supply (a minimum of 500 circular mils per ampere is recommended).

2-24. To determine the proper wire size (AWG) for load leads, a nomograph (Figure 2-3) is provided. The wire size is determined by two factors; maximum current carrying capacity recommend for any AWG (500 circular mils per ampere) and the maximum tolerable voltage drop across the load leads.

Table 2-2. Front Panel Functions

Index	Name	Function
1	LOCAL VOLTAGE CURRENT V_{LIM}	Three green LED indicators, illuminates when the three rear panel slot accessible switches are placed in the LOCAL position.
2	ON	A rocker switch that controls the power supply's line power, illuminates when placed in the ON position.
3	VOLTS	A voltmeter that indicates the output voltage of the power supply.
4	AMPERES	An ammeter that indicates the current being supplied to the load by the power supply.
5	V_{LIM}	An amber LED indicator that illuminates when the output of the supply is being limited by the V_{LIM} function.
6	CROWBAR	A red LED indicator that illuminates when the supply is latched in the O.V. trip condition.
7	V_{LIM} SET	A recessed screwdriver adjust potentiometer, adjust the set point of the V_{LIM} from 5% to 110% of the rated voltage when LOCAL V_{LIM} is selected.
8	CONTROL MODE VOLTAGE	A green LED indicator, illuminates when the power supply is operating in the constant voltage mode.
9	CONTROL MODE CURRENT	An amber LED indicator, illuminates when the power supply is operating in the constant current mode.
10	VOLTAGE	A 10-turn potentiometer, adjusts the output voltage of the power supply when local voltage operation is selected.
11	CURRENT	A 10-turn potentiometer, sets the maximum current supplied to the load when local current operation is selected.
12	OUTPUT MONITOR −S +S	2-test jacks, allows monitoring the output voltage of the power supply.

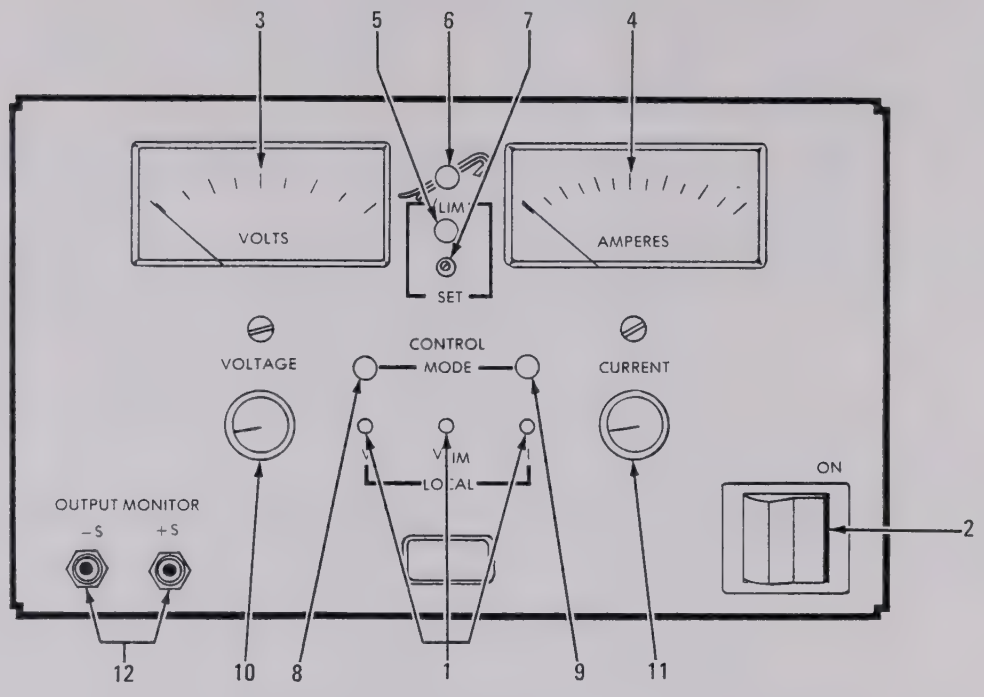


Figure 2-1. Front Panel Functions

2-25. To find the maximum current capacity for the standard wire size (AWG), lay a straight edge from the AWG on scale 2 to point A on scale 3, then read the maximum off of scale 1. To find the voltage drop in millivolts per foot for a known wire size and operating current, lay a straight edge from the operating current on scale 1 to the AWG on scale 2, then read the voltage drop on scale 3.

2-26. To find the wire size required for a known operating current and a known maximum tolerable voltage drop across the supply leads, first, ascertain the maximum tolerable IR drop in millivolts per foot of lead (sum of positive and negative leads). Then lay a straight edge from this value on scale 3 to the known operating current on scale 1 and read the wire size in AWG off of scale 2.

2-27. Local Control Operation

2-28. Set the rear panel accessed V, I and V_{LIM} switches to their LOCAL (down) position. Set the front panel VOLTAGE and CURRENT controls full CCW. Rotate the V_{LIM} SET screwdriver adjustment potentiometer full CW. Set the power switch to its ON position and verify that the power switch indicator illuminates and the LOCAL-VOLTAGE, CURRENT and V_{LIM} LED indicators illuminates. As soon as the power switch is set ON, the power supplyis ready for use.

2-29. To set up the power supply for constant voltage operation with current limiting, perform the following steps:

1. Monitor the front panel VOLTS meter, or connect a DVM to the OUTPUT MONITOR jacks, and adjusts the VOLTAGE control for the required output voltage. If the power supply is equipped with option 09 control locks, lock the VOLTAGE control.

2. Place a short across the +V and −V terminals on the rear panel barrier strip.

3. Monitor the front panel AMPERES meter and adjust the CURRENT control for the required maximum current output (current limit level). If the power supply is equipped with control locks, lock the CURRENT control.

Table 2-3. Rear Panel Functions

Index	Name	Function
1	$\overset{+}{V}$ $\overset{+}{S}$ G $\overline{S}$ $\overline{V}$	A 5-terminal barrier strip, provides output, sensing and ground connections for the power supply.
2	115 V 10 A 230 V 5 A	Fuse holders contain a 10 A or 5 A fuse for 115 Vac or 230 Vac operation respectively
3	P2	An access slot to a 20-pin PCB edge connector which provides remote programming interface to the power supply. Refer to Table 2-4 for the pin designations of this 20-pin programming connector.
4	REMOTE V I V_{LIM} LOCAL	3-access slots to 3 PCB mounted selector switches that provide for the independent selection of LOCAL control or REMOTE programming of the V, I or V_{LIM} functions.

4. Remove the short from the +V and −V terminals.

To set the V_{LIM} level perform the following steps:

1. Monitor the front panel VOLTS meter, or connect a DVM to the OUTPUT MONITOR jacks.

2. Adjust the VOLTAGE control to the required V_{LIM} point, as indicated on the VOLTS meter or DVM.

3. Rotate the V_{LIM} SET screwdriver adjustment CCW until the V_{LIM} LED indicator just illuminates.

4. With the VOLTAGE control reduce the output voltage and verify that the V_{LIM} LED extinguishes. Then slowly increase the output voltage and verify that the V_{LIM} LED illuminates at the required V_{LIM} set point.

5. Reset the VOLTAGE control to the required output voltage.

2-30. The power supply will provide constant current operation automatically, when the load demand exceeds the current level set by the CURRENT control. When the supply switches into its constant current

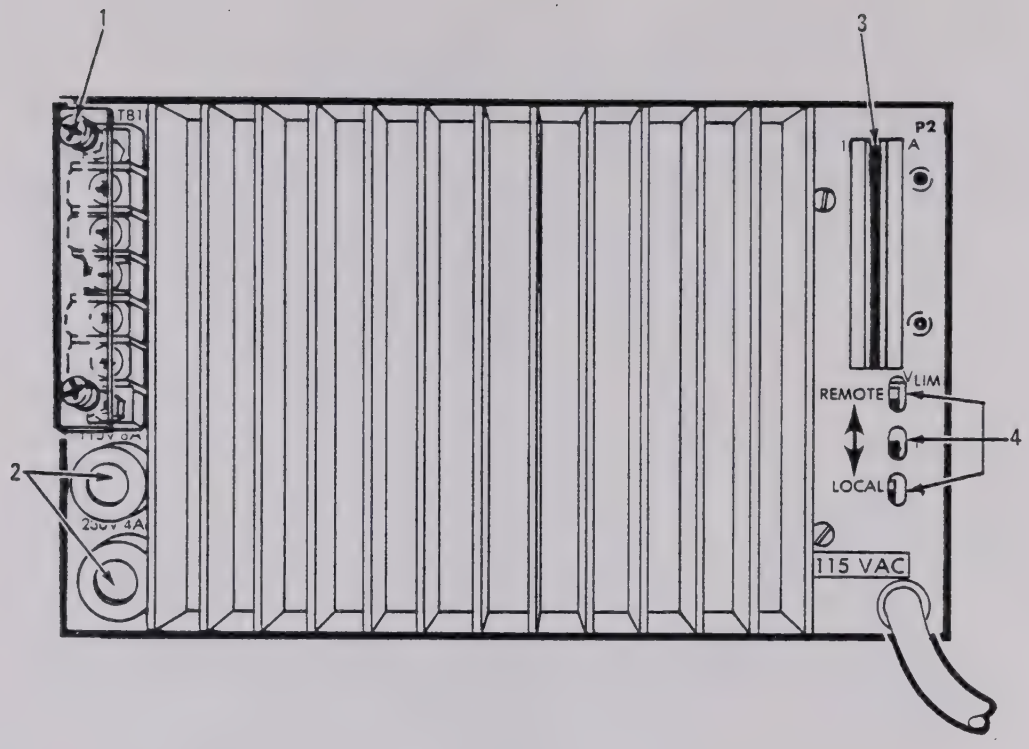


Figure 2-2. Rear Panel Functions

Table 2-4. Programming Connector P2

Pin Number	Function
1	V_{LIM}-mode Flag
2	V-mode Flag
3	Ground
4	+V −6.2 V
5, E	Interlock (internal interconnection)
6	+S +15 V
7, H	Remote voltage control input
8, J	+S (all control signals are referenced to +S)
9, K	Remote current control input
10, L	Remote V_{LIM} control input
A	Crowbar Flag
B	I-mode Flag
C	Flag Common
D	O.V. Indication
F	Restore

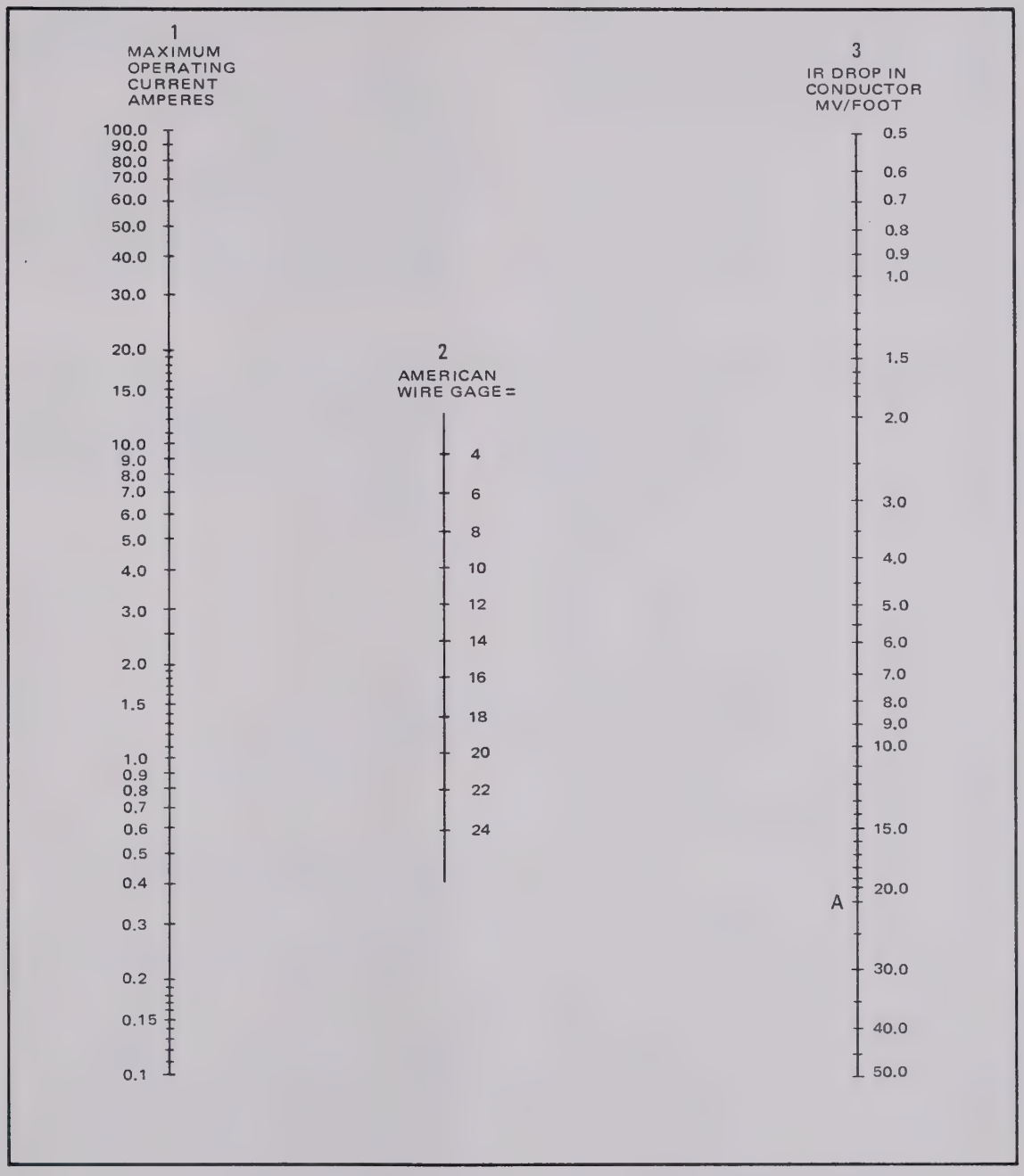


Figure 2-3. Load Lead Wire Size Monograph

control mode the CONTROL MODE CURRENT LED illuminates and the CONTROL MODE VOLTAGE LED extinguishes. The point at which the constant voltage/constant current mode change takes place is a function of variations in load conditions and will occur at a critical value of load resistance $R_C = E_S/I_S$, where E_S is the front panel VOLTAGE control setting and I_S is the front panel CURRENT control setting.

2-31. Remote Programming Operation

2-32. Set the rear panel accessed V, I and V_{LIM} switches to their REMOTE (up) position. Set the power switch to its ON position and verify that the power switch indicator illuminates. Verify that the LOCAL -VOLTAGE, CURRENT and V_{LIM} LED indicators are extinguished, thus indicating that local front panel control of the functions are disabled and the supply may be controlled by a remote programming source. Connect the programming device via cable and connector to the rear panel accessed P2 connector. Table 2-5 provides the remote programming format for the PHR-Series power supplies.

NOTE

If for any reason the output voltage of the supply should momentarily exceed the V_{LIM} set point by 1% of the full output voltage rating, the O.V. circuit will trip, crowbaring the output of the supply.

The O.V. trip condition is indicated by the illumination of the red crowbar LED and a zero indication on the panel voltmeter. Remotely the O.V. trip is signalled by an O.V. flag voltage on pins of P2.

If no failure has occurred the O.V. trip can be cleared and operation restored by cycling the power ON switch OFF/ON or by initiating a RESTORE command via the programmer.

Table 2-5. PHR-Series Programming Format

Program Function	P2 Pin Connections	Program Operation
Voltage Output (V)	7 and H	00.0 to +10.0 V provides 00% to 100% of the rated output voltage.
Current Limit (I)	9 and K	0 to −1 mA provides 00% to 100% of the rated current limit level.
Voltage Limiting (V_{LIM})	10 and L	00.0 to +10.9 V provides 00% to 109% of the rated output voltage as the V_{LIM} set point.
Program Common	8 and J	Common dc return for programming signals.

CHAPTER 3
PRINCIPLES OF OPERATION

3-1. PHR-SERIES FUNCTIONAL DESCRIPTION

3-2. The following functional description is referenced to the PHR-Series schematic diagrams located at the end of chapter 6 of this manual. Reference designators assigned to the electronic components are divided into two numerical series: 1 through 99 pcb assembly mounted components, and 101 through 199 chassis, heatsink, front and rear panel mounted components.

3-3. The overall function of the power supply is to transform and rectify the ac input line voltage into a well regulated, stable, and adjustable dc output. In performing these functions, the circuitry can be divided into the following subfunctions:

1. Main Power Circuit
2. Auxiliary Power Circuits
3. Voltage Control
4. Current Sink Circuit
5. Current Control
6. Voltage Limit and Overvoltage Crowbar Circuits
7. Pre-Regulator.

3-4. MAIN POWER CIRCUIT

3-5. All power for the supply is fed through a captive 3-conductor line cord. Rear panel mounted slow blow fuses F101 and F102 in each side of the line protect the supply from overload fault conditions. A front panel mounted indicating rocker switch, S101, breaks both sides of the line to the power transformers when the supply is turned off.

3-6. Transformer T101 is the main power source for the load. The primary may be strapped for 115 V ac line operation (W2 and W3) or for 230 V operation (W1). The secondary on the 20 V unit is center tapped and balanced, thus requiring only two diodes for full wave rectification. The higher output voltage units utilize a non-tapped secondary feeding a full wave bridge. The transformers are designed with a high leakage inductance to limit inrush current to the filter capacitor, C101. SCRs CR101 and CR102 are employed as rectifiers in order that the conduction angle can be controlled to regulate the voltage across the pass transistors. This will be discussed in more detail under the section on Pre-regulator.

3-7. A separate transformer T102 is used to supply the phase reference for the pre-regulator circuit as well as housekeeping power to the amplifier pcb assembly A1. Its primary can also be strapped for either 115 or 230 V ac line operation. Separating the magnetics improves the output voltage waveforms of the secondaries on T102.

3-8. Raw output from the main filter capacitor C101 is applied through fast blow fuse F103 to the series pass regulating transistors, Q101 through Q103, located on the rear panel heat sink. The fuse acts as added protection for the rectifiers in the event of a pass transistor short. Two or three pass transistors are used in parallel depending on the rated current of the supply. In the PHR 20-12, Q101 through Q103 are high gain darlingtons, all in parallel, with current balancing resistors in series with each emitter. In the higher voltage but lower current units, Q102 and Q103 are the pass transistors and Q101 is a current driver, making the combination a darlington type circuit. In either case, base drive is fed through thermal switch S102 mounted on the heat sink. Should the heat sink temperature exceed 135°C, S102 will open and shut down the supply until the pass transistors cool to a safer temperature. Regulator operation will be discussed further in sections on voltage and control.

3-9. Output from the pass transistors is fed through the current measuring shunt R31 on the amplifier pcb assembly A1 and thence to the rear panel output terminal +V on TB101. Additional filtering is supplied by C102 in series with R109 across the output. Resistors R101 and R105 are bleeder resistors to discharge the filter capacitors when power is removed and CR104 protects the supply from an externally applied reverse voltage. Other elements across the output will be explained later.

3-10. AUXILIARY POWER CIRCUIT

3-11. Additional power at fixed voltages is necessary to operate the control circuitry of the supply. This is obtained from T102. Secondary 7-8-9 is connected to the amplifier pcb assembly where the

voltage is full wave rectified and filtered by CR24, CR25 and C17. The 30 V output of this auxiliary supply is split into two components relative to the positive output of the main supply: a highly regulated +15 V referred to the positive sense (+S) terminal of the main supply and a regulated −6.2 V referred to the positive voltage (+V) output terminal of the main supply. The two reference points are almost the same and can only differ by up to 0.5 V when using remote load sensing.

3-12. The +15 V is regulated by series pass transistor Q6 controlled by differential amplifier U4. One input to U4 is a highly stable 6.4 V provided by reference diode CR28. The other input comes from a voltage divider comprised of R56 and R54 whose ratio is such that the regulator output is forced to 15 V in order to satisfy the input balance requirements of U4. Transistor Q5 is a field effect transistor used as a constant current source and zener diode CR29 provides an offset so that the output of U4 is within its operating range at 10 V.

3-13. The −6 V is generated and regulated by zener reference diode CR22, connected between +V and the negaive return of the 30 V auxiliary supply.

3-14. VOLTAGE CONTROL

3-15. In the normal voltage control mode, the output voltage of the supply is controlled by the combination of amplifier U1, emitter follower Q1 and the pass transistors Q101 through Q103. They form the major part of a closed loop, negative feedback control system. They may also be considered together as a power operational amplifier referred to plus sense. The output stage (pass transistors) is an inverter when measuring from plus sense, thus U1 input pin 3 is actually the inverting input. Pin 2 is then the non-inverting or reference input and is tied to plus sense through R11.

On the schematic plus sense is indicated by an inverted triangle symbol (⏚)

3-16. In an operational amplifier, the output voltage is $e_o = e_{in}\ (R_f/R_{in})$. Here the output voltage is measured at the −S terminal of the supply and the feedback resistor R_f is R_3 connected between the output (−S) and the input to the op-amp, pin 3 of U1. The controlling input voltage e_{in} and the input resistor R_{in} are selected by the LOCAL-REMOTE switch S1. In the position shown (remote) the input resistance is the series combination of R5, R6 and R2. It is adjusted by R6 to a nominal 10 kΩ. The input voltage of from zero to +10 V referred to +S is supplied by the remote programming source. The feedback resistor is also 1 kΩ per full scale volt. Thus a 50 V full scale output supply has a 50 kΩ feedback. At +10 V input, supplying +1 mA, the supply output is forced to −50 V so that the feedback current is −1 mA and just balances the input current. The summing junction, pin 3 of U1, is thus held at the same potential as pin 2, i.e., +S. The ratio of output voltage to programming voltage is fixed at 5 and applies over the entire operating range from zero volts and up. For a 20 V full scale supply, the feedback resistor R3 is 20 kΩ and the ratio is 2, etc.

3-17. In the LOCAL position of S1, the input resistor is R4 and R7 in series and is nominally 15 kΩ. The input voltage comes from the front panel VOLTAGE control potentiometer R111 and is adjustable from zero to +15 V. The full scale input current is the same as in remote programming, i.e., +1 mA. The "B" pole of S1 is open in LOCAL and allows the 10 mA current from the 30 V auxiliary supply through R53 to flow through the front panel green "V LOCAL" LED.

3-18. Transistor Q4 supplies a small (5 mA) reverse current to the supply output. To program zero volts output then requires that the pass transistors conduct an equal current. This keeps the voltage amplifier in control even at zero volts and allows for some leakage current in the pass transistors.

3-19. CURRENT SINK CIRCUIT

3-20. The current sink circuit provides for the discharge of the power supplies output capacitors C102 and C103 and any external capacitance related to the load during dynamic down programming of the supply.

3-21. The output of U1, pin 6, is normally at +3.5 to +4 V and Q2, a PNP transistor, is biased off. However, during down programming, the output of U1 goes negative until the output of the supply drops to the lower value. This negative potential turns on Q2 which then supplies a constant current base drive to the "pull down" transistor Q104. Transistor Q104 is also current limited by its emitter resistor R107 and dual diode CR105. The circuit will sink current at the approximate limit values listed below down to an output voltage level of about 2 V. Below 2 V the sink current will decrease rapidly.

Table 3-1. Sink Current Limit Values

Power Supply Rated Output Voltage	Sink Current Limit Value
20 V	2.5
50 V	1.0
100 V	0.4

3-22. Figure 3-1 provides an example of the current sink function of the PHR 100-4 power supply being down programmed. The response time period is determined by the change in voltage and the load capacitance. The response time into a resistive load is specified as less than 2 ms. When operating into a capacitive load, this step response time may increase due to the added capacitance. Response time can be calculated by the following equation:

$$\text{Response time} = \frac{\triangle E(C_i + C_e)}{I_1}$$

where $\triangle E$ is the change in voltage.

C_i is the supplies internal capacitance (C102 and C103).

C_e is the external load capacitance.

I_1 is the sink current limit value.

Unit of measure are in seconds, volts, farads and amperes.

3-23. CURRENT CONTROL

3-24. Circuitry is provided in the power supply to sharply limit the amount of current which can be delivered to the load. The value can be programmed remotely or set locally by the front panel current control potentiometer. Current is obviously a function of load impedance: no load, no current; short circuit, maximum programmed current. The crossover from constant voltage to constant current mode is automatic. The point at which the operating mode changes is a function of the load and occurs at a critical value of the load resistance $R_C = E_S/I_S$, where E_S is the voltage control setting and I_S is the current control setting.

3-25. Current control is accomplished by IC operational amplifier U3. A measure of the output current is provided by the voltage drop across the current shunt resistor R31. The output or +V end of the shunt is connected to U3 input pin 3 as the reference level. The other input, pin 2, is the summing junction and to that point is connected the positive feedback current from R34 and R35 and the negative input (control) current whose source is switch selected by S2A. When in the current control mode, these two currents must be equal and opposite so that the potential of input pin 2 is the same as the reference level on input 3. The shunt resistor R31 is chosen so that full rated output current will develop a voltage drop of between 120 and 136 mV. The feedback resistance is then adjusted to always give a corresponding +1 mA. Thus the control input sink current is from zero to −1 mA.

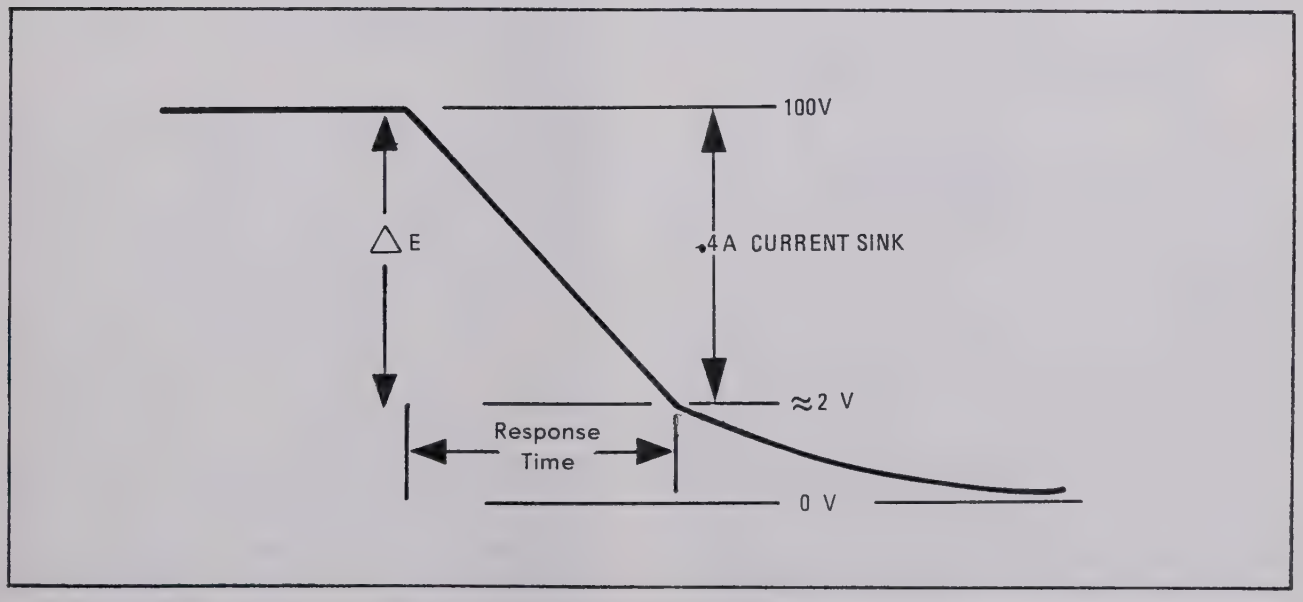


Figure 3-1. Current Sink Function

3-26. Switch S2A is shown in the remote control position. The remote controlling current sink is connected to pins 9 and K of connector A1P2. For best accuracy, it should be a true constant current sink and can be returned to +S on pins 8 and J. In LOCAL position, the current sink is through R10 and R37 to the front panel current control R111. In LOCAL, S2B unshorts the front panel green I LOCAL LED so it indicates that the control is active.

3-27. The output of U3 is connected through isolating diode CR8 to pin 8 of U1. Pin 8 serves as an input to the output stage of U1. Any signal connected here which pulls the voltage lower than that determined by the input to U1 will control the output. In Current Control mode, the input to U3 pin 2 is only slightly negative so that the output of U3 goes low enough to control the loop.

3-28. When the supply is not in current mode, the output of U3 is clamped at slightly over 7 V by zener diode CR26 connected to pin 8. Isolation diode CR8 is back biased and the current amplifier has no effect on the supplies operation. Under this condition, zener diode CR27 does not have enough voltage across it to conduct. However, when the output of U3 lowers as current control begins, CR27 will conduct and Q8 will turn on. That turns on the front panel I Mode LED and the LED in optoisolator U5 whose output at pin B of the remote control connector A1P2 signals the current mode status. When Q8 turns on, its collector goes high and turns off Q7, turning off the front panel V Mode LED and the isolated V-Mode status flag at pin 2 of A1P2.

3-29. VOLTAGE LIMIT AND OVER-VOLTAGE CROWBAR CIRCUIT

3-30. The voltage limiting (V_{LIM}) and overvoltage crowbar protection functions are provided to protect the load or the power supply itself from overvoltage due to programming, external voltage or internal malfunctions.

3-31. Operational amplifier U2B is the voltage limit control amplifier. The reference input pin 7 is tied to +S through R24. Pin 6 acts as the summing junction; the feedback resistor is R26 tied to −S and the input resistor is R25. The voltage applied to the V_{LIM} input, at R25, is normally higher than the voltage programming input to U1. Thus the output of the power supply is below the V_{LIM} set point. Under these conditions the positive input current to U2B is greater than the feedback current. The excess flows through CR13 to +S. The net effect is a positive potential on pin 6 which drives the output pin 9 of U2B up to its clamp level of about +7.5 V, determined by zener CR5 and diode CR4. At this potential isolating diode CR6 in the output to U1 pin 8 is always back biased and there is no effect on the normal operation of the control circuitry.

3-32. If the main voltage control input to U1 is increased so that the output of the supply rises to the V_{LIM} set point, the feedback current through R26 equals the V_{LIM} input current and the input to U2B approaches balance. The output pin 9 drops low enough so that CR6 conducts and now U2B controls the output of U1 instead of the voltage control input. Further increases in the Voltage programming input will have no effect; the supply output is clamped and controlled by U2B.

3-33. When in the V_{LIM} control state, the output of U2B is low enough to permit zener diode CR9 to conduct, turning on Q9. This turns on the front panel V_{LIM} LED and provides an optically isolated status flag at pin 1 of control connector A1P2. Local or remote control of the V_{LIM} input is selected by S3. In Remote the input may be anything from zero to +11 V, allowing setting up to 110% of full scale. In Local the front panel screwdriver adjust V_{LIM} SET potentiometer, A3R1, sets the limit and the green LED DS7 indicates that local control is enabled.

3-34 The Overvoltage Crowbar is an additional protective circuit that operates in conjunction with the limiting circuit. Its purpose is to ensure that the output voltage does not exceed some maximum preset level under external or internal fault conditions by placing a short or "crowbar" across the output terminals if the output voltage exceeds the V_{LIM} setting by 1% of rated output.

3-35. This is accomplished by amplifier U2A which together with its associated components acts as a latching comparator. Its noninverting input pin 4 is connected to the corresponding input on the V_{LIM} amplifier through resistor R27. Therefore it receives the same signal relative to output versus limiting setting. However its output does not change sign (from + to −) when the V_{LIM} amplifier takes control because the reference input pin 3 is biased negative 0.1 V. If the V_{LIM} circuit cannot control the output, either through reducing drive to the pass transistors or operating the sink transistor Q104, and the output goes an additional 1% of full scale more negative then input (pin 4) goes negative with respect to pin 3. At this point the output pin 1 goes negative. This is fed back through diode CR18 and resistor R28 to the input, which acts to latch the comparator in this condition.

3-36. Integrated circuit U2A has three outputs. The first, through diode CR12 and current limiting resistor R2, turns on transistor driver Q3 which supplies a current pulse from its collector to fire the crowbar scr, CR103. When the crowbar conducts, it rapidly pulls down any voltage present at the supply output to < 1 V. If the overvoltage were due to a shorted pass transistor, the crowbar current would blow fuse F103 and disable the supply.

3-37. The second output of U2A is the isolating diode CR7 to pin 8 of U1. This is a somewhat redundant drive pull-down, duplicated by the V_{LIM} amplifier through CR6, but it remains as long as U2A stays latched. The third output through zener diode CR19 turns on transistor Q10. This turns on the front panel CROWBAR LED and provides an optically isolated status flag at pin A of control connector A1P2.

3-38. Once the fault condition causing the crowbar has been cleared, the latch can be reset either by a positive reset pulse from the programmer through pin F of A1P2 or by turning the supply OFF and then back on again.

3-39. PRE-REGULATOR

3-40. The pre-regulator circuitry is added to increase the efficiency of the power supply and is independent in operation from all of the circuitry discussed heretofore. It does this by maintaining a more or less constant low voltage across the pass transistors (i.e., from collector to emitter) irrespective of the supplies output voltage. The regulation is accomplished by controlling the firing angle of the rectifying scrs and adds no significant losses over that of a conventional diode rectifier front end except for a small increase in transformer loss.

3-41. An example will illustrate the advantage: In a 50 V, 8 A non pre-regulated supply operating at 5 V output with an 8 A load current and an unregulated input voltage of 60 V, the loss in the series pass element would be $(60 - 5)\ (8) = 440$ W. Given the same output in a pre-regulated supply that maintains 11 V across the series pass (i.e., 16 V unregulated input), the loss is only $(11)\ (8) = 88$ W, a saving of about 350 W of heat to be dissipated. Beside increase efficiency at output voltages less than full scale, it means that fewer transistors on a much smaller heat sink can do the equivalent regulating job.

3-42. The regulator circuitry is mounted on a separate pcb and is shown on a separate schematic in Chapter 6. The zero reference potential pin 10 is the cathode of the scrs which is also the collector of the pass transistor. Power and phase synchronization come from a secondary on T102 to pins 4 and 5 with center tap to pin 10. Pins 7 and 8 connect to the scr gates and provide the trigger pulse to fire them. Pin 2 is the main input and senses the voltage drop across the pass transistors. Pin 1 is an auxiliary input that provides some correcting signal over the full output voltage range.

3-43. The circuit is essentially a relaxation oscillator consisting of R2 and R4, C2 and Q2. Power is applied to it in 120 Hz pulses. The output of diodes CR1 and CR4 is an unfiltered full wave rectified sine wave.

3-44. The wave is clipped by zener diodes CR5 and CR6 into an approximate trapezoidal shape with a 13.8 V amplitude. Of this total, the voltage across CR6, 8.2 V, is applied to the unijunction transistor Q2.

3-45. At the beginning of each half wave, when the voltage is zero, Q2 conducts if there is any residual voltage on C2 and discharges the capacitor through R12. When the rectified voltage rises to 13.8 V, C2 starts to charge through R2 and R4. When the emitter of Q2 reaches about 75% of the voltage across the bases of the unijunction (i.e., 6.1 V), the emitter base 1 junction breaks down to near zero resistance. This dumps the entire charge on C2 through R10 and R11 into the gates of the rectifying scrs. The scr that is forward biased turns on and conducts current from the transformer into the filter capacitor C101 and through the pass transistor to the load. This action repeats each half cycle of the line frequency, with the scrs firing alternately.

3-46. Not all of the current flowing through R2 and R4 goes to charge C2. Some is bled off through R8 and R9 to the output side of the linear regulator and is proportional to the voltage drop across the pass transistors. Thus, for example, if the output voltage of the supply is reduced, the voltage drop across the pass transistors increases. To counteract that, more current flows through R8 and R9. This robs charging current from C2 and it takes longer to charge to the firing point of Q2. The scrs fire later in the cycle when T101s instantaneous output voltage is less and C101 discharges to a new lower voltage which brings the pass drop back into line. The opposite happens when the supplies output voltage is increased. Less charging current is diverted so that the scrs fire at an earlier phase angle and raise the voltage on C101.

3-47. Because the loop gain of the pre-regulator circuit is not very high, for stability reasons, two correcting circuits are included to improve performance under varying line voltage and output voltage conditions. Rectifiers CR2 and CR3 together with zener CR7 from a negative sink that diverts C2 charging current through R3. As line voltage increases the sink voltage increases, diverting more charging current and delaying the scr firing time to keep the voltage on C101 more constant. The other circuit is Q1 and its associated resistors which performs a negative voltage to positive current conversion and acts as positive feedback. As the supply output is increased, it causes more charging current to flow from the collector of Q1 to C2, advancing the firing angle and thus helping to increase the voltage on C101.

CHAPTER 4

MAINTENANCE AND CALIBRATION

4-1. INTRODUCTION

4-2. This chapter provides information on alignment and calibration procedures, routine maintenance, and troubleshooting techniques. Whenever the power supply requires factory service the nearest Systron Donner representative should be contacted. He can provide field service at your location or arrange factory return if necessary. Address all inquiries on operation, service or application to your nearest service representative or service division. Specify the model and complete serial number in all correspondence.

4-3. TEST EQUIPMENT

4-4. Table 4-1 lists the test equipment required for the test and calibration procedures. Alternate test equipment with equivalent characteristics may be used when the recommended types are not available.

4-5. CALIBRATION AND TEST

4-6. Prepower Check Procedure

1. Ensure that the shorting links are connected across the +V and +S and the −V and −S terminals on rear panel barrier strip TB101 to allow local sensing and regulation.

2. Ensure that the power supply is wired for the line voltage to be used. Refer to the schematic diagrams at the end of Chapter 6 and the following power transformer connection chart.

NOTE

The Power Supply is normally factory wired for 104 to 127 V ac.

3. Ensure that 10 A slow-blow fuses are installed in the rear panel fuse holders F101 and F102.

4. Manually zero both meters.

5. Set VOLTAGE and CURRENT controls to zero (CCW). Set the LOCAL/REMOTE switches to REMOTE.

4-7. Calibration

NOTE

Perform REMOTE calibration first. The setting of REMOTE I CAL affects the setting of LOCAL I CAL. Also the V and I zero adjustments are more important for remote opertion than for local front panel control.

1. Connect to a calibrated P1 DAC in local control and apply power.

2. On the P1 programmer, set V = 100.00, I = 05, $V_{LIM} \geq 105$ and press ENTER and RESTORE. Connect a DVM to the sense terminals using the 1 V range. Adjust the V-Zero potentiometer for a reading nearest zero.

3. Set DVM to 100 V range. Set and enter V = 100.00, I = 05, and $V_{LIM} \geq 105$. Adjust REM V Cal POT for rated full scale voltage. Adjust V MTR Cal POT on front panel pcb for full scale reading on panel voltmeter. Re-check at zero and again at full scale.

4. Set and enter V = 0500, I = 00, and V_{LIM} = 110. Connect an appropriate shunt across the +/−V terminals. Measure the current with a DVM on the 1V scale. Adjust the I zero POT for zero current.

5. Set I = 99. Adjust the REM I Cal POT for 99% of full scale current.

6. Disconnect programmer and set all switches back to LOCAL. Turn the CURRENT control fully CW. Adjust LOCAL I Cal for a reading of slightly over full scale ($\leq$ 101%). Adjust the control for a full scale reading (100%). Adjust the I MTR Cal for a full scale reading on the front panel meter.

Table 4-1. Recommend Test Equipment

Oscilloscope Tektronic 5000 Series	1 mV/Div. resolution 10 MHz bandwidth
Digital Multimeter	5½ digit ± 0.01%
Variable Auto-transformer (Variac)	0-140 Vac 600 watts
Control PCB Extender Systron Donner P/N 065428	
Current Measuring Shunt Resistor	5 A or 15 A capacity 0.1%
Appropriate Load Resistors or Load Bank	
Power Supply Programmer Systron Donner P1 (or if not available)	
Precision Voltage Source	0 to 10 V with a minimum 1 mA current capacity

Table 4-2. Power Transformer Primary Connections

Line Voltages	T101 Jumpers	T102 Jumpers
100/130	W2, W3	W4, W5
200/260	W1	W6

7. Disconnect the shunt load and connect the DVM (100 V scale) across the sense leads. Turn the V_{LIM} and VOLTAGE controls fully CW. Adjust LOCAL V Cal for slightly over full scale (102%).

4-8. Pre-Regulator Adjustments

1. Using a calibrated ac voltmeter and a variac, place a full load (voltage and current) on the supply. Monitor the PASS XSTR voltage drop by connecting the voltmeter to the test points on the pre-regulator board (plus to REF, minus to +V).

2. For 60 Hz operation, set the line voltage to 100 V and adjust R2 for a reading of 5 V (PHR 20), 8 V (PHR 50), or 12 V (PHR 100).

a. Set the line voltage to 115 V. The reading should be 6.5 V (PHR 20), 10 V (PHR 50), or 16 V (PHR 100).

b. Set the line voltage to 100 V and short the output. The reading should be 7 V (PHR 20), 11.5 V (PHR 50), or 18 V (PHR 100).

4-9. POWER SUPPLY TROUBLESHOOTING

4-10. If a malfunction is suspected, the following procedures should be performed to isolate the fault.

4-11. Loads and Interconnections.

4-12. To ensure that the malfunction is not due to any external influence, remove the power supply from the system and perform the following procedure.

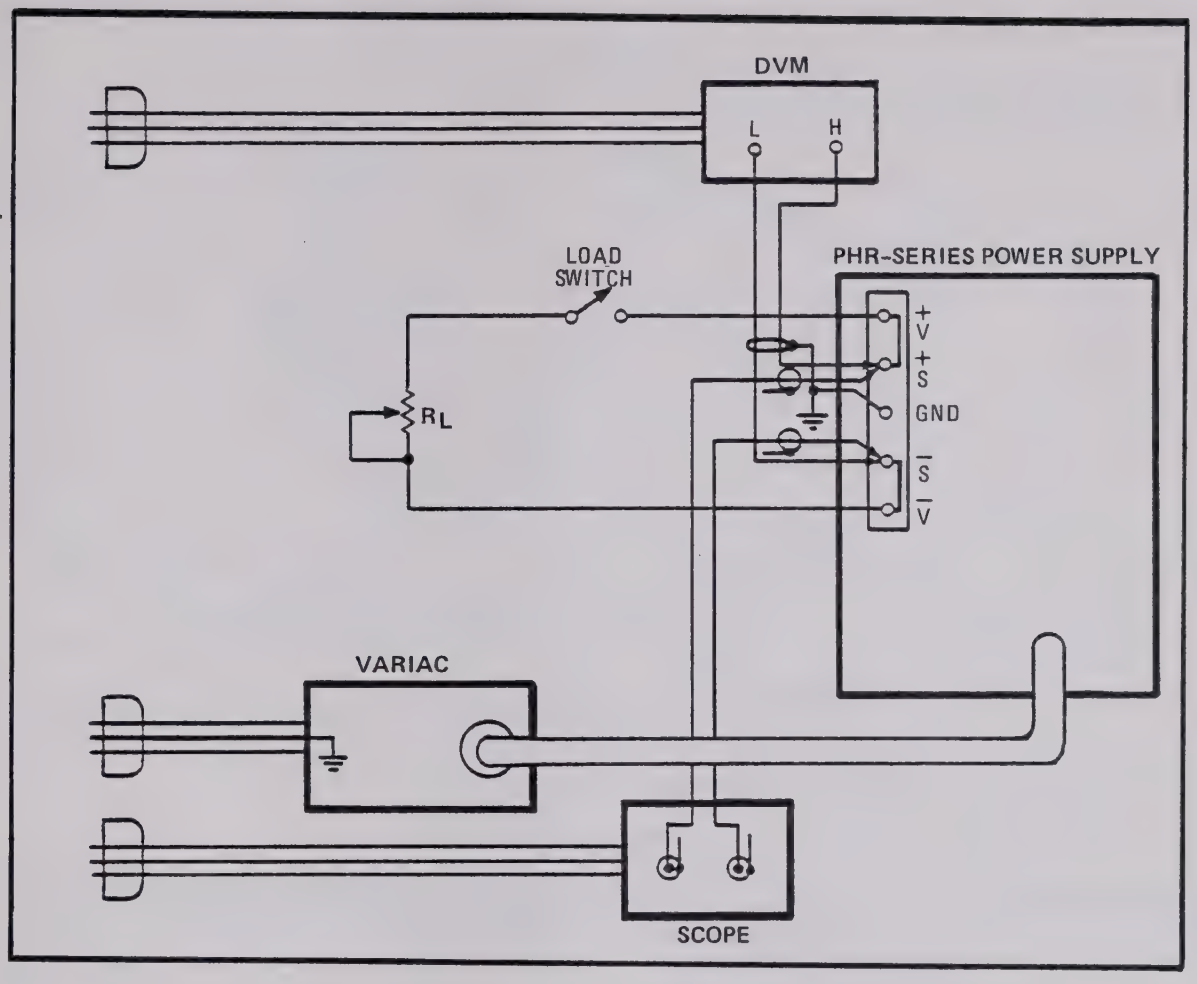


Figure 4-1. Voltage Mode Test Configuration

1. Install shorting links on the rear panel TB101 barrier strip between +V and +S and −V and −S terminals. Ensure that the shorting link connections are securely made to prevent any deterioration of supply regulation.

2. Connect a resistive load across the +V and −V terminals having the proper ohmic value and wattage rating to provide a maximum rated load to the power supply.

MODEL	LOAD RESISTOR	
PHR 20-12	1.7	240 W
PHR 50-8	6.3	400 W
PHR 100-4	25	400 W

Ensure that the load connections are securely made and that the wiring used is of sufficient gauge to carry the current.

3. Apply nominal ac line power and check for normal operation i.e., rated output and regulation. Proper operation at this time would indicate that any malfunction previously encountered, was external in nature.

4. Check all interconnects, loads, remote programming devices, shielding and grounding that interfaced with the power supply for any faults or application errors.

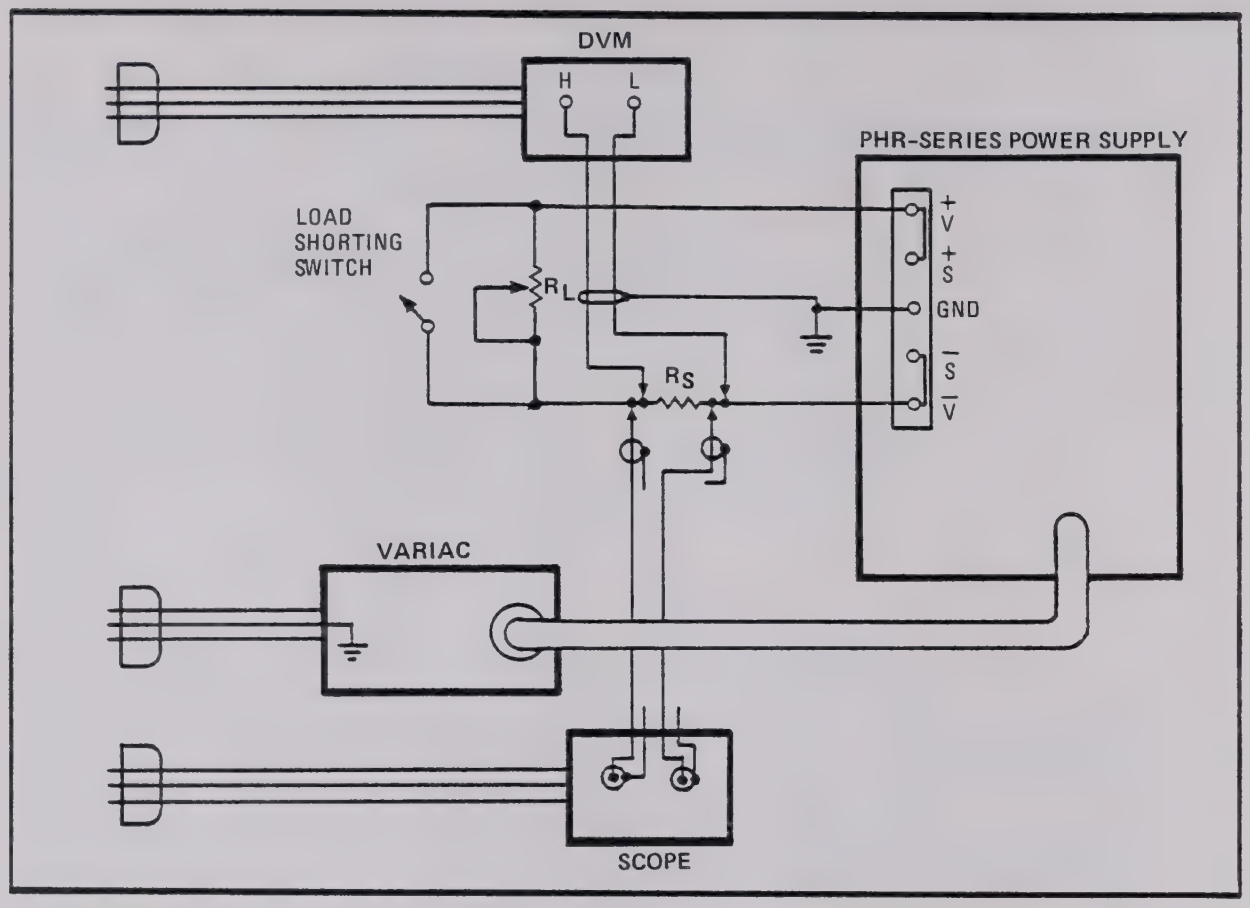


Figure 4-2. Current Mode Test Configuration

4-13. Power Supply Fault Isolation

4-14. A good understanding of the principles of operation of the power supply is essential to efficient troubleshooting techniques. For this reason, it is recommended that Chapter 3 of this manual be reviewed before attempting to troubleshoot the unit.

4-15. Before proceeding with the troubleshooting procedure check for obvious troubles such as an open fuse, defective power cord, out of tolerance line power. Next visually inspect the power supply's mechanical integrity for such items as loose plug-in Control PCB assembly and loose or displaced component parts and wiring that could cause shorts or opens. Then check for mechanical and thermal damage, i.e., broken, discolored or charred component parts.

4-16. If the source of the trouble cannot be detected by visual inspection or the malfunction corrected by performing the calibration procedures, then proceed with the following steps.

1. Configure the power supply per paragraph 4-8, steps 1 and 2.

2. Verify that the rear panel accessed LOCAL-REMOTE V, I and V_{LIM} switches are placed in their LOCAL (down) positions.

3. Apply power and rotate the front panel VOLTAGE and CURRENT controls fully CW.

4. Using a DVM or a voltmeter having an impedance of 50 kΩ/V check the voltage at test points or across the components listed in Table 4-3.

Table 4-3. PHR-Series Test Voltages

Test Point or Component	Function	Voltage — Vdc PHR20-12	PHR50-8	PHR100-4
C101	Main output filter	27 V	60 V	116 V
C17	Aux. regulator filter	30 V	30 V	30 V
CR29	Level shift zener	5.6 V ± 0.3	5.6 V ± 0.3	5.6 V ± 0.3
CR28	+S +15 V reference zener	6.4 V ± 0.3	6.4 V ± 0.3	6.4 V ± 0.3
CR22	+V −6.2 V reference zener	6.2 V ± 0.3	6.2 V ± 0.3	6.2 V ± 0.3
C19	+S +15 V	15 V ± 0.6	15 V ± 0.6	15 V ± 0.6

NOTE:

All voltage measurements are normal power supply operation, 115V nominal ac line input, and full rated output voltage and current.

5. If voltage checks show no noticeable deviations from the prescribed values in Table 4-3 disconnect ac power and proceed with a point-to-point resistance check.

6. If the problem is of an intermittent nature, dynamic changes where noted when making dc voltage checks or high ripple is suspected, the use of an oscilloscope is indicated.

CHAPTER 5

REPLACEABLE PARTS

5-1. INTRODUCTION

5-2. This chapter contains the parts lists for each assembly in the PHR-Series Power Supply. Chapter 6 shows the assemblies where the listed parts are installed. Ordering information is included and should be used when purchasing parts from the factory. Explanation of the column listings and Table 5-1 Manufacturer's Code-To-Name Index are also included.

5-3. PART ORDERING INFORMATION

5-4. To order a part from the Replaceable Parts List, state the Systron Donner part number, indicate the quantity required and address the order to the nearest Systron Donner Sales or Service Center.

5-5. To order a part not listed in the Replaceable Parts List, state the instrument model number, instrument serial number, the description and function of the part and the number of parts required. Address the order to the nearest Systron Donner Sales or Service Center.

5-6. PARTS LIST

5-7. Table 5-1 gives the code-to-name information for the manufacturers listed in the replacement parts lists. The replaceable parts lists are placed in a numbered sequence. Each column in the parts lists provide specific information relating to the listed parts as follows:

(1) DESIGNATOR: Item numbers, reference numbers and used on codes applicable to assemblies. Reference numbers are listed in alpha-numerical order. Used on Codes 1, 2 and 3 define which supply the component is used on.

(2) COMPONENT NOMENCLATURE AND DESCRIPTION: Component names and specifications are provided in this column and include value, tolerance, wattage rating, working voltage, construction, etc.

(3) MANUFACTURER'S CODE: H4-2 Federal Supply Code numbers are listed to identify component manufacturers. A Manufacturers Index is provided in this chapter for cross-reference.

(4) MANUFACTURER'S PART NUMBER: True manufacturer part numbers are listed in this column.

(5) SD STOCK NUMBER: The Systron Donner stock number is listed in this column.

(6) T/Q (Total Quantity): This quantity, appearing after an item entry, indicates the number of times the component is used in that assembly. The total quantity for each part is given only once - at the first appearance of the part number in the list.

Table 5-1. Manufacturer's Code-to-Name Index

Mfr Code	Manufacturer Name	Address	Zip Code
00779	Amp, Inc.	Harrisburg, PA	17105
01121	Allen Bradley Co.	Milwaukee, WI	53204
01295	Texas Instruments Inc. Semiconductor & Components Division	Dallas, TX	75265
02660	Amphenol Corp.	Broadview, IL	60153
02735	RCA Corp. Solid State Division	Somerville, NJ	08876

Table 5-1. Manufacturer's Code-to-Name Index (Cont'd)

Mfr Code	Manufacturer Name	Address	Zip Code
02768	Illinois Tool Works, Inc. Fastex Division	Des Plaines, IL	60016
02888	Pyrofilm Corp.	Whippany, NY	07981
03296	Nylon Molding Corp.	Springfield, NJ	07081
03508	General Electric Company Semiconductor Products Division	Auburn, NY	13021
03877	Transitron Electronic Corp.	Wakefield, MA	01880
04713	Motorola Semiconductor Products Division	Phoenix, AZ	85008
05245	Corcom Inc.	Libertyville, IL	60048
05464	Industrial Electronic Engineers Inc.	Van Nuys, CA	91405
05574	Viking Connectors Inc.	Chatsworth, CA	91311
06383	Panduit Corp.	Tinley Park, IL	60477
06540	Mite Corp. Amatom Electronic Hardware Division	New Haven, CT	06515
06560	Airco Inc. Airco Electronics	Nogales, AZ	85621
06720	Omark Industries, Inc.	Portland, OR	97222
06763	Fairchild Camera & Instrument Corp. Semiconductor Division	Mountain View, CA	94042
06776	Robinson Nugent Inc.	New Albany, IN	47150
07088	Kelvin Electric Co.	Van Nuys, CA.	91401
08289	Delbert Blinn Co. Inc.	Pomona, CA	91766
08520	Wakefield Engineering Inc.	Wakefield, MA	01880
08547	R. G. Wallace Co. Inc.	Compton, CA	90220
09353	C & K Components Inc.	Newton, MA	02158
11236	CTS of Berne Inc. Division of Scientific Components Corp.	Berne, IN	46711
12014	Chicago Rivet & Machine Co.	Bellwood, IL	60104
12517	Component Research Co., Inc.	Santa Monica, CA	90404
12598	RLC Electronics Inc.	Kisco, NY	10549
12617	Hamlin Inc.	Lake Mills, WI	53551
13103	Thermalloy Co.	Dallas, TX	75234
13715	Fairchild Camera & Instrument Corp. Components Group	San Rafael, CA	94903
14752	Electro Cube Inc.	San Gabriel, CA	91776
15513	Data Display Products	Los Angeles, CA	90045
15542	Mini-Circuits Laboratory	Brooklyn, NY	11235
15572	Vollrath Refrigeration Inc.	River Falls, WI	54022
15818	Teledyne Semiconductor	Mountain View, CA	94040
16197	Chemistron Corp. Division of Sterling Instrument and Electronic Co.		
16299	Corning Glass Works	Raleigh, NC	27604
16546	USCC/Centralab	Burbank, CA	91504
16733	Cablewave Systems Inc.	North Haven, CT	06473
18324	Signetics, Corp.	Sunnyvale, CA	94086
18612	Vishay Resistor Products Division Vishay Intertechnology Inc.	Malvern, PA	19355
19701	Mepco/Electra Inc.	Mineral Wells, TX	76067
20908	Electronic Concepts	No. Charlottesville, VA	22904
21847	Aertech Industries Division of TRW Inc.	Sunnyvale, CA	94086
23172	Alpha Wire Corp	Elizabeth, NJ	08830
23880	Stanford Applied Engineering Inc.	Santa Clara, CA	95050
23936	Pamotor - Division of William J. Purdy Co.	Burlingame, CA	94010

Table 5-1. Manufacturer's Code-to-Name Index (Cont'd)

Mfr Code	Manufacturer Name	Address	Zip Code
24335	Cooper Laboratories Inc.	Mystic, CT	
24655	General Radio	Concord, MA	01742
25088	Siemens Corp.	So. Iselin, NJ	08830
25403	Amperex Electronic Corp. Semiconductor and Microcircuits Division	Slatersville, RI	02876
26654	Varadyne Industries Inc.	Santa Monica, CA	90404
26695	Compac Corp. Kleen-Stik Products Div.	Newark, NJ	07114
26806	American Zettler Inc.	Costa Mesa, CA	92626
27014	National Semiconductors Corp.	Santa Clara, CA	95051
27018	Optimum Designs Inc.	New York, NY	
27264	Molex Inc.	Lisle, IL	60532
27556	IMB Electronic Products Inc.	Santa Fe Springs, CA	90670
28480	Hewlett-Packard Co.	Palo Alto, CA	94304
28520	Heyman Mfg. Co.	Kenilworth, NJ	07033
29111	Systron Donner Corp. Advanced Components Division	Sunnyvale, CA	94086
31433	Union Carbide Corp.	Greenville, SC	29606
31938	International Electro Exchange Inc.	Eden Prairie, NM	55343
32293	Intersil Inc.	Cupertino, CA	95014
32767	Griffith Plastic Corp.	Burlingame, CA	94010
44655	Ohmite Mfg. Co.	Skokie, IL	60076
50522	Monsanto Industrial Chemicals Co.	Palo Alto, CA	94303
51181	Keytronics Inc.	Endicott, NY	13760
51495	R & D Plastics	Richmond, CA	94804
52542	Systron Donner, Instrument Division	Concord, CA	94518
53101	Garner Glass Co.	Claremont, CA	91711
54453	Sullins Electronic Corp.	San Marcos, CA	92069
56289	Sprague Electric Co.	North Adams, MA	01247
70903	Belden Corp.	Chicago, IL	60644
71279	Cambridge Thermonic Corp.	Cambridge, MA	01238
71590	Globe-Union Inc. Centralab Electronics Division	Fort Dodge, IA	50501
71707	Coto Coil Co., Inc.	Providence, RI	02905
71785	TRW Inc. Cinch Connectors Division	Elk Grove Village, IL	60007
72136	Electro Motive Corp	Florence, SC	
72259	Nytronics Inc.	New York, NY	10016
72982	Erie Technological Products Inc.	Erie, PA	16512
73138	Beckman Instruments Inc. Helipot Division	Fullerton, CA	92634
73508	Brawley Felt Co.	Northampton, MA	01060
73734	Federal Screw Products Inc.	Chicago, IL	60618
73803	Texas Instruments Inc. Metallurgical Materials Division	Attleboro, MA	02703
73899	J F D Electronics Corp.	Brooklyn, NY	11219
73957	Groov-Pin Corp.	Ridgefield, NJ	07657
74970	E. F. Johnson Co.	Waseca, MN	56093
75042	TRW Electronic Components Fixed Resistors Philadelphia Div.	Philadelphia, PA	19108
75915	Tracor Littelfuse Inc.	Des Plaines, IL	60016
76381	Minnesota Mining & Mfg. Co.	St. Paul, MN	55101
76854	Oak Industries Inc. Switch Div.	Crystal Lake, IL	60014
77969	Rubbercraft Corp. of Calif. Ltd.	Torrance, CA	90507
78189	Illinois Tool Works Inc. Shakeproof Division	Elgin, IL	60120

Table 5-1. Manufacturer's Code-to-Name Index (Cont'd)

Mfr Code	Manufacturer Name	Address	Zip Code
78526	Stanwyck Winding, Division of San Fernando Electric Mfg. Co. Inc.	Newburgh, NY	
78553	Tinnerman Products, Inc.	Cleveland, OH	44129
79727	C-W Industries	Warminister, PA	18974
79963	Zierick Mfg. Co.	Mt. Kisco, NY	10549
81073	Grayhill Inc.	La Grange, IL	60525
81349	MIL STD		
81483	International Rectifier Corp.	Los Angeles, CA	90069
83330	Smith Herman H. Inc.	Brooklyn, NY	11207
86928	Seastrom Mfg. Co. Inc.	Glendale, CA	91201
88245	Litton Systems Inc. Useco Division	Van Nuys, CA	91409
91406	Augat Inc.	Attleboro, MA	02703
91418	Radio Materials Corp.	Chicago, IL	60646
91537	Magazines For Industry Inc.	New York, NY	10017
91637	Dale Electronics Inc.	Columbus, NE	68601
91673	Epiphone Inc.	New York, NY	10017
91836	Kings Electronics Co. Inc.	Tuckahoe, NY	10707
92194	Alpha Wire Corp.	Elizabeth, NJ	08830
92702	IMC Magnetics Corp. Eastern Division	Westbury Long Island, NY	11591
95348	Gordos Corp.	Bloomfield, NJ	07003
95978	Weckesser Co. Inc.	Chicago, IL	60641
96733	F. Schumacher & Co.	New York, NY	10018
96906	MIL STD		
98289	Curtis-Allbrite Lighting Ltd.	Toronto, Ontario, CAN	
98921	O and M Mfg. Co.	Houston, TX	77029
98978	International Electronic Research Corp.	Burbank, CA	91502
99392	S T M Corp.	Oakland, CA	94601
99800	American Precision Industries Inc. Delevan Division	East Aurora, NY	14052
99899	Narda Microwave Corp.	Plainview Long Island, NY	11803
99942	Globe-Union Inc. Centralab Semiconductor Centralab Electronics Division	Milwaukee, WI	53201

REPLACEABLE PARTS LIST

TITLE **PHR SERIES SHIPPING ASSEMBLY**

ITEM #	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
		1	ASSEMBLY, Shipping	52542	06557801	06557801	1
		2	ASSEMBLY, Shipping	52542	06557802	06557802	1
		3	ASSEMBLY, Shipping	52542	06557803	06557803	1
		1-3	ASSEMBLY, Cover	52542	06526701	06526701	1
		1-3	COVER, Protective	52542	065427	065427	1
		1	ASSEMBLY, Test & Chassis	52542	06559601	06559601	1
		2	ASSEMBLY, Test & Chassis	52542	06559602	06559602	1
		3	ASSEMBLY, Test & Chassis	52542	06559603	06559603	1
		1-3	CHASSIS	52542	065596	065596	1
		1-3	FEET, Rubber	52542	840192	840192	4
	A1	1	ASSEMBLY, Amplifier PC	52542	06557701	06557701	1
	A1	2	ASSEMBLY, Amplifier PC	52542	06557702	06557702	1
	A1	3	ASSEMBLY, Amplifier PC	52542	06557703	06557703	1
	A2	1	ASSEMBLY, Pre-Reg PC	52542	06557601	06557601	1
	A2	2	ASSEMBLY, Pre-Reg PC	52542	06557602	06557602	1
	A2	3	ASSEMBLY, Pre-Reg PC	52542	06557603	06557603	1
	C101	1	CAP, El Can 48000μF, 40V	52542	116606	116606	1
	C101	2	CAP, El Can 15600μF, 75V	52542	820353	820353	1
	C101	3	CAP, El Can 3300μF, 200V	52542	820180	820180	1
	C104	1-3	CAP, Mylar 1.0μF 20%, 400V	27556	ZAZE105	100138	1
	F103	1	FUSE, 15 AMP	52542	870100	870100	1
	F103	2	FUSE, 3AGMB 10A 250V	75915	314010	100586	1
	F103	3	FUSE, 3AGMB 5A 250V	75915	312005	100582	1
	J101	1-3	CONNECTOR, PC Edge 22 pos	05574	2VK22S/1-2	102637	1
	J102	1-3	CONNECTOR, PC Edge 10 pos	05574	2VK10S/1-2	101233	1
	R101	1	RESISTOR, WW 500Ω 5%, 5W	12697	VC5E	640460	1
	R101	2	RESISTOR, WW 2.0K 5%, 5W	24681	VL5-42000	640530	1
	R101	3	RESISTOR, CRWWL 8K, 5W	52592	640554	640554	1
	R112	1-3	RESISTOR, CC 1.5Ω 5%, 1/4W	01121	EB15G5	112558	1
	T101	1	TRANSFORMER	52542	504348	504348	1
	T101	2	TRANSFORMER	52542	504353	504353	1
	T101	3	TRANSFORMER	52542	504354	504354	1
	T102	1-3	TRANSFORMER, Auxiliary	52542	504352	504352	1
	XF103	1-3	BLOCK, Fuse 15A 250V	71400	2839	116921	

USED ON CODE: 1 = PHR20-12 2 = PHR50-8 3 = PHR100-4

REPLACEABLE PARTS LIST

TITLE **PHR SERIES SHIPPING ASSEMBLY (Cont'd)**

ITEM #	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
		1-3	BRACKET, Transformer	52542	06565901	06565901	2
		1-3	BRACKET, Transformer	52542	06565902	06565902	2
		1-3	BRACKET, CAP	52542	T900065	T900065	1
		1	ASSEMBLY, Heatsink	52542	06558601	06558601	1
		2	ASSEMBLY, Heatsink	52542	06558602	06558602	1
		3	ASSEMBLY, Heatsink	52542	06558603	06558603	1
		1-3	PLATE, Mtg	52542	065586	065581	1
		1-3	SPACER, MF	06540	9738-SS-0632-3A	860013	3
		1-3	NAMEPLATE	52542	T101040	T101040	1
		1-3	CABLE, Interconnect	52542	065634	065634	1
		1	ASSEMBLY, Front Panel	52542	06558101	06558101	1
		2	ASSEMBLY, Front Panel	52542	06558102	06558102	1
		3	ASSEMBLY, Front Panel	52542	06558103	06558103	1
		1	ASSEMBLY, Rear Panel	52542	06558301	06558301	1
		2	ASSEMBLY, Rear Panel	52542	06558302	06558302	1
		3	ASSEMBLY, Rear Panel	52542	06558303	06558303	1

USED ON CODE: 1 = PHR20-12 2 = PHR50-8 3 = PHR100-4

REPLACEABLE PARTS LIST

TITLE PHR SERIES COVER ASSEMBLY 06526701 REV A

ITEM #	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
		1-3	COVER, Top	52542	065267	065267	1
		1-3	HANDLE	12136	382-394SS	117497	2
		1-3	STRAP, Handle	52547	03357003	03357003	1
		1-3	WASHER, Flat	96906	MS15795-808	100648	2
		1-3	NUT, Hex #10-32	96906	MS35650-104	100709	2
		1-3	WASHER, S-L #10	96906	MS35338-138	100714	2

USED ON CODE: 1 = PHR20-12 2 = PHR50-8 3 = PHR100-4

REPLACEABLE PARTS LIST

TITLE PHR SERIES CHASSIS ASSEMBLY REV A

ITEM #	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
		1	ASSEMBLY, Chassis	52542	06559601	06559601	1
		2	ASSEMBLY, Chassis	52542	06559602	06559602	1
		3	ASSEMBLY, Chassis	52542	06559603	06559603	1
		1-3	CHASSIS	52542	065596	065596	1
		1	ASSEMBLY, Front Panel	52542	06558101	06558101	1
		2	ASSEMBLY, Front Panel	52542	06558102	06558102	1
		3	ASSEMBLY, Front Panel	52542	06558103	06558103	1
		1	ASSEMBLY, Rear Panel	52542	06558301	06558301	1
		2	ASSEMBLY, Rear Panel	52542	06558302	06558302	1
		3	ASSEMBLY, Rear Panel	52542	06558303	06558303	1
		1	ASSEMBLY, PC Board	52542	06557701	06557701	1
		2	ASSEMBLY, PC Board	52542	06557702	06557702	1
		3	ASSEMBLY, PC Board	52542	06557703	06557703	1
		1	ASSEMBLY, Heatsink	52542	06558501	06558501	1
		2	ASSEMBLY, Heatsink	52542	06558502	06558502	1
		3	ASSEMBLY, Heatsink	52542	06558503	06558503	1
	C101	1	CAPACITOR, El Can 4800μF,40V	52542		116606	1
	C101	2	CAPACITOR, El Can 15,600μF,75V	52542	820353	820353	1
	C101	3	CAPACITOR, El Can 3300μF,200V	52542	820180	820180	1
	C104	1	CAPACITOR, Mylar 1.0μF 20%, 400V	27556	ZA2E105	100138	1
	C104	2	CAPACITOR, Mylar 1.0μF 20%, 400V	27556	ZA2E105	100138	1
	C104	3	CAP, Mylar 1.0μF 20%, 400V	27556	ZA2E105	100138	1
	F103	1	FUSE, 15 Amp 3AG	52542	870100	870100	1
	F103	2	FUSE, 10 Amp 3AG	75915	314010	100586	1
	F103	3	FUSE, 5 Amp 250V	75915	312005	100582	1
	R101	1	RESISTOR, WW 500Ω 5%, 5W	12697	VC5E	640460	1
	R101	2	RESISTOR, WW 2K 5%, 5W	24681	VL5-42000	640530	1
	R101	3	RESISTOR, WW 8K 5%, 5W	24681	VL5-42500	640554	1
	R112	1	RESISTOR, CC 1.5Ω 5%, 1/2W	01121	EB15G5	112558	1
	R112	2	RESISTOR, CC 1.5 5%, 1/2W	01121	EB15G5	112558	1
	R112	3	RESISTOR, CC 1.5Ω 5%, 1/2W	01121	EB15G5	112558	1
	T101	1	TRANSFORMER	52542	504348	504348	1

USED ON CODE: 1 = PHR20-12 2 = PHR50-8 3 = PHR100-4

REPLACEABLE PARTS LIST

TITLE **PHR SERIES CHASSIS ASSEMBLY REV A (Cont'd)**

ITEM #	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	T101	2	TRANSFORMER	52542	504353	504353	1
	T101	3	TRANSFORMER	52542	504354	504354	1
	T102	1-3	TRANSFORMER	52542	504352	504352	1
		1-3	CLAMP, Capacitor	52542	T900065	T900065	1
		1-3	ASSEMBLY, Cable	52542	06547601	06547601	Ref
		1-3	PLATE, PC Board Mtg	52542	065586	065586	1
		1-3	SPACER, MF 3/8 Long	06540	9738-SS-0632	103394	1
		1-3	SCREW, PHM 4-40 × 3/8	96906	MS51957-15	10062606	4
		1-3	WASHER, Flat #	96906	MS15795-803	100703	4
		1-3	WASHER, S-L #4	96906	MS35338-135	100711	4
		1-3	NUT, Hex #4	96906	MS35649-244	100707	1
		1-3	SCREW, PHM 6-32 × 9/16	08547	By Description	100851	1
		1-3	SCREW, PHM 6-32 × 1/2	96906	MS51957-30	10063208	4
		1-3	SCREW, PHM 6-32 × 3/8	96906	MS51957-28	10063206	18
		1-3	SCREW, FHM 6-32 × 5/16	96906	MS24693-C25	10073105	3
		1, 2	WASHER, Flat #6	96906	MS15795-805	100704	12
		3	WASHER, Flat #6	96906	MS15795-805	100704	11
		1, 2	WASHER, S-L #6	96906	MS35338-136	100712	17
		3	WASHER, S-L #6	96906	MS35338-136	100712	16
		1, 2	NUT, Hex 6-32	96906	MS35649-264	100706	4
		3	NUT, Hex 6-32	96906	MS35649-264	100706	3
		1-3	NUT, Kep 6-32	78189	511-061800-00	100862	10
		1-3	NUT, Kep 8-32	78189	511-081800-00	100940	1
		1-3	SCREW, PHM 10-32 × 1/2	96906	MS51958-63	10064408	4
		1-3	WASHER, Flat #10	96906	MS15795-808	100648	4
		1-3	WASHER, S-L #10	96906	MS35338-138	100714	4
		1-3	NUT, Hex #10	96906	MS35650-104	100709	4
		1-3	CONNECTOR, Rectangular 5-pin	27264	07-01-7051	116546	1
		1-3	LABEL, Warning	52542	065535	065535	1
		1-3	NAME PLATE	52542	T101040	T101040	1
		1, 2	SCREW, BHM 10-32 × 4				2
		3	JUMPER, 0-OHM	52510	L-2007-1	102879	2
		1-3	FOOT, Rubber	52542	840192	840192	4
		1	ASSEMBLY, Pre-Regulator PC	52542	06557601	06557601	1

USED ON CODE: 1 = PHR20-12 2 = PHR50-8 3 = PHR100-4

REPLACEABLE PARTS LIST

TITLE PHR SERIES CHASSIS ASSEMBLY REV A (Cont'd)

ITEM #	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
		2	ASSEMBLY, Pre-Regulator PC	52542	06557602	06557602	1
		3	ASSEMBLY, Pre-Regulator PC	52542	06557603	06557603	1
		1, 2	LUG, Solder #10	79963	622-.196	100491	4
		3	LUG, Solder #10	79963	622-.196	100491	3
		1-3	FUSE BLOCK 15A 250V	71400	2839	116921	1
		1, 2	BRACKET, Transformer	52542	06565901	06565901	1
		1, 2	BRACKET, Transformer	52542	06565902	06565902	
		1, 2	BUSHING, Nylon	83330	2537	103655	4
		3	BRACKET, Transformer	52542	06565901	06565901	1
		1, 2	CLAMP, Cable 3/8	95987	3/8 - 4NA	100718	1
		3	BRACKET, Transformer	52542	06565902	06565902	1
		3	BUSHING, Nylon	83330	2537	103655	4
		3	CLAMP, Cable	95987	3/8 - 4NA	100718	1

USED ON CODE: 1 = PHR20-12 2 = PHR50-8 3 = PHR100-4

REPLACEABLE PARTS LIST

TITLE PHR SERIES SCR HEATSINK ASSEMBLY

ITEM #	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
		1	ASSEMBLY, Heatsink	52542	06558501	06558501	1
		2	ASSEMBLY, Heatsink	52542	06558502	06558502	1
		3	ASSEMBLY, Heatsink	52542	06558503	06558503	1
		1-3	HEATSINK	52542	065585	065585	1
	C105, C106	1	CAPACITOR, Cer Disc 0.1μF 100V	56289	TGP10	800176	2
	C105, C106	2	CAPACITOR, Cer 0.1μF 100V	52542	800176	800176	2
	C105, C106	3	CAPACITOR, Mylar .047μ F, 10%, 400V	24138	CM470-4-A	800155	2
	CR101, CR102	1	DIODE, SCR 35A 100V	04713	2N3896	116604	2
	CR101, CR102	2	DIODE, SCR 20A 200V	04713	MCR3918-4	116605	2
	CR101, CR102	3	DIODE, SCR 35A 200V	03508	C35B	720000	2
	CR107, CR108	2	DIODE, Rectifier 200V	02735	1N1202A	102884	2
	CR107, CR108	3	DIODE, Rectifier 300V	02735	1N1203A	720133	2
	R113, R114	1	RESISTOR, CC 10Ω 5%, 1/2W	01121	EB1005	101632	2
	R113, R114	2, 3	RESISTOR, CC 10Ω 5% 1/4W	01121	EB1005	101632	2
		1-3	RING, Insulator	52542	T990340	T990340	2
		1-3	LUG, Solder	86928	5411-35	T960640	2
			WASHER, Mica	52542	T990295	T990295	4
		1-3	WASHER, Flat	52542	T990040	T990040	2
		1-3	WASHER, Lock	52542	T990180	T990180	2
		1-3	NUT, Hex	52542	T990128	T980128	2
		1	TERMINAL	17117	3340-14-1	860070	2
		2, 3	LUG, Diode	52542	960085	960085	2
		2, 3	WASHER, Mica	52542	990307	990307	4
		2, 3	RING, Insulator	52542	990350	990350	2
		2, 3	WASHER, Flat	52542	990306	990306	2
		2, 3	WASHER, Lock	52542	990170	990170	2
		2, 3	NUT, Hex	52542	980101	980101	2
		2, 3	TERMINAL, SCWMT	17117	3023-14-1	860070	2

USED ON CODE: 1 = PHR20-12 2 = PHR50-8 3 = PHR100-4

REPLACEABLE PARTS LIST

TITLE PHR SERIES FRONT PANEL ASSEMBLY REV A

ITEM #	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
		1	ASSEMBLY, Front Panel	52542	06558101	06558101	1
		2	ASSEMBLY, Front Panel	52542	06558102	06558102	1
		3	ASSEMBLY, Front Panel	52542	06558103	06558103	1
		1-3	PANEL, Front	52542	065581	065581	1
	A3	1-3	ASSEMBLY, Indicator PC	52542	06558701	06558701	1
	J102	1-3	TEST POINT, Red	52542	T920260	T920260	1
	J103	1-3	TEST POINT, Black	52542	T920190	T920190	1
	M101	1	ASSEMBLY, Meter 0-20V	52542	117656	117656	1
	M101	2	ASSEMBLY, Meter 0-50V	52542	06539201	06539201	1
	M101	3	ASSEMBLY, Meter 0-100V	52542	06539301	06539301	1
	M102	1	ASSEMBLY, Meter 0-12A	52542	06563701	06563701	1
	M102	2	ASSEMBLY, Meter 0-8A	52542	06558201	06558201	1
	M102	3	ASSEMBLY, Meter 0-4A	52542	06557901	06557901	1
	R110	1-3	RESISTOR, Variable 5K 10%, 2W	11534	35045-1-502	600317	1
	R112	1-3	RESISTOR, Variable 2K 10%, 2W	80294	3540S-1-202	600209	1
	S101	1-3	SWITCH, AC On/Off	52542	116654	116654	1
		1-3	WASHER, Flat #6	96906	MS15795-805	100704	4
		1-3	WASHER, Lock Int. Tooth #6	96906	MS35333-71	100647	3
		1-3	SPACER, Hex Threaded 6-32	83330	9293	116920	3
		1-3	WASHER, Lock Int. Tooth	52542	T990190	T990190	2
		1-3	WASHER, Flat	52542	T990043	T990043	2
		1-3	KNOB, No Skirt	86797	RB-67-1-DC-M-L	100976	2
		1-3	NUT, Hex	01121	M-4721	100671	2
		1-3	WASHER, Lock Int. Tooth	78189	1214-05	103004	2
		1	FOILCAL, 0-20V 12A	52542	781801	781801	1
		2	FOILCAL, 0-50V 8A	52542	781800	781800	1
		3	FOILCAL, 0-100V 4A	52542	781699	781699	1
		1-3	ASSEMBLY, Cable	52542	065655	065655	Ref
		1-3	SCREW, Button Head 6-32 × 1/4	96906	By Description	116919	3
		1-3	SCREW, PHM 6-32 × 1/4	96906	MS51957-26	10063204	3

USED ON CODE: 1 = PHR20-12 2 = PHR50-8 3 = PHR100-4

REPLACEABLE PARTS LIST

TITLE **PHR SERIES REAR PANEL ASSEMBLY REV A**

ITEM #	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
		1	ASSEMBLY, Rear Panel	52542	06558301	06558301	1
		2	ASSEMBLY, Rear Panel	52542	06558302	06558302	1
		3	ASSEMBLY, Rear Panel	52542	06558303	06558303	1
		1-3	PANEL, Rear	52542	065583	065583	1
		1-3	HEATSINK	52542	065654	065654	1
		1-3	SCREW, PHM 6-32 × 3/8	96906	MS51957-28	10063206	3
		1-3	WASHER, S-L #6	96906	MS35338-136	100712	9
	C102	1	CAPACITOR, Tant 15μF 10%,	56289	150D156X9035R2	106525	1
	C102	2	CAPACITOR, ELAX 10μF 100V	56289	TE1407	106449	1
	C102	3	CAPACITOR, Mylar 5μF 5%, 200V	27556	BA2173	106476	1
	C103	1	CAPACITOR, Cer 1μF 50V	52542	800304	800304	1
	CR103	1, 2	DIODE, SCR 35A	04713	2N3896	116604	1
	CR103	3	DIODE, SCR 20A	04713	MCR3918-4	116605	1
	CR104	1	DIODE, Rectifier	04713	MR1120	720129	1
	CR104, CR106	2	DIODE, SCR	04713	MR1121	720132	2
	CR104, CR106	3	DIODE, Rectifier 200V	04713	1N1202A	102884	2
	CR105	1-3	DIODE, Signal 20V	03508	1N4829	100443	1
	F101, F102	1-3	FUSE, Slo-Blo 10A	52542	870201	870201	2
	F102	1	FUSE, Slo-Blo 5A (E Option)	75915	313005	100583	1
	Q101	2, 3	TRANSISTOR, SINPN	04713	2N3738	102738	1
	Q101-Q103	1	TRANSISTOR, SINPN 40V	80103	PMD16K40	117649	3
	Q102, Q103	2	TRANSISTOR, SINPN	04713	2N6258	700087	2
	Q102, Q103	3	TRANSISTOR, SINPN 150V	02735	2N6259	116876	2
	Q104	1	TRANSISTOR, SINPN Select	52542	705021	705071	1
	Q104	2	TRANSISTOR, SINPN Selected	52542	705071	705071	1
	Q104	3	TRANSISTOR, SINPN	02735	2N3442	700410	1
	R102, R104	1	RESISTOR, WW 0.1Ω 3%, 5W	15915	TSA5	630018	3

USED ON CODE: 1 = PHR20-12 2 = PHR50-8 3 = PHR100-4

REPLACEABLE PARTS LIST

TITLE PHR SERIES REAR PANEL ASSEMBLY REV A (Cont'd)

ITEM #	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	R102,	2, 3	RESISTOR, CC 12 Ω 5%, 1/2W	01121	EB1205	106005	1
	R103, R104	2	RESISTOR, WW 0.1Ω 3%, 5W	15915	TSA5	630018	2
	R103, R104	3	RESISTOR, WW 0.2 Ω 3%, 5W	15915	TS2C	630004	2
	R105	1	RESISTOR, WW 100 Ω 5%, 10W	12697	VPR10F-100 OHM	117666	1
	R105	2	RESISTOR, WW 700 Ω 5%, 10W	12697	VPR10F-700 OHM	117667	1
	R105	3	RESISTOR, WW 2.5K 5%, 10W	12697	VP10F-2.5K	118002	1
	R106, R108	1-3	RESISTOR, CC 1K 5%, 1/4W	01121	CB1025	101569	2
	R107	1	RESISTOR, WW 0.3 Ω 3%, 3W	12463	T-2A	630006	1
	R107	2	RESISTOR, WW 0.7 Ω 3%, 3W	15915	TS-2C	630020	1
	R107	3	RESISTOR, WW 1.67 Ω 3%, 3W	15915	TS-2C	630040	1
	R109	1, 2	RESISTOR, WW 0.1 Ω 3%, 3W	15915	T53.1 5%NI	117797	1
	R109	3	RESISTOR, WW 0.33 Ω 3%, 5W	15915	T53.33 5%NI	117798	1
	S102	1-3	SWITCH, Thermal	14604	2450-88-16	880007	1
		1	SOCKET, Trans	52542	830101	830101	4
		2, 3	SOCKET, Trans	52542	830101	830101	3
		1	WASHER, Mica	08289	DM-101	T990290	4
		2, 3	WASHER, Mica	08289	DM-101	T990290	6
		1	SCREW, Sheet Metal 6 × 1/2 PH Type B	52542	T970890	T970890	4
		2, 3	SCREW, Sheet Metal 6 × 1/2 PH Type B	52542	T970890	T970890	6
		1-3	SCREW, PHM 2-56 × 1/4	96906	MS51957-3	10062504	2
		1-3	WASHER, S-L #2	96906	MS35337-77	100661	2
		1-3	TERMINAL #4	17117	2304-14-1	860020	3
		1-3	WASHER, S-L #4	96906	MS35338-135	100711	3
		1-3	SCREW, PHM 4-40 × 5/16	96906	MS51957-14	10062605	3
		1-3	SCREW, PHM 6-32 × 2 1/4	08547	By Description	10063236	1
		1	WASHER, Flat #6	96906	MS15795-805	100704	3
		2, 3	WASHER, Flat #6	96906	MS15795-805	100704	1
		1-3	WASHER, Fibre Flat	83330	2163	100974	2
		1-3	NUT, Kep 6-32	78189	511-061800-00	100862	1
		1-3	LUG, Diode	86928	5411-35	T960640	1

USED ON CODE: 1 = PHR20-12 2 = PHR50-8 3 = PHR100-4

REPLACEABLE PARTS LIST

TITLE PHR SERIES REAR PANEL ASSEMBLY REV A (Cont'd)

ITEM #	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
		1-3	WASHER, Mica	52542	T990295	T990295	2
		1-3	RING, Insulator	52542	T990340	T990340	1
		1-3	WASHER, Flat	52542	T990340	T990040	1
		1-3	WASHER, S-L	52542	T990180	T990180	1
		1-3	NUT, Hex	52542	T980128	T980128	1
		1	WASHER, Mica	52542	T990307	T990307	2
		2, 3	WASHER, Mica	52542	T990307	T990307	4
		1	RING, Insulator	52542	T990350	T990350	1
		2, 3	RING, Insulator	52542	T990350	T990350	2
		1	WASHER, Flat #10	96906	MS15795-808	100648	1
		2, 3	WASHER, Flat #10	96906	MS15795-808	100648	2
		1	WASHER, S-L #10	96906	MS35333-73	100698	1
		2, 3	WASHER, S-L #10	96906	MS35333-73	100698	1
		1	HOLDER, Fuse	75915	345002	117381	1
		2, 3	HOLDER, Fuse	75915	345002	117381	2
		1	WASHER, Int. Tooth	78189	1224-02	T990200	1
		2, 3	WASHER, Int. Tooth	78189	1224-02	T990200	2
		1-3	CORD, Line	70903	17514	116905	1
		1-3	STRAIN RELEASE	52542	T930000	T930000	1
		1-3	LUG, Crimp	52542	T960565	T960565	1
		1	SCREW, Sheet Metal 6 × 5/8 Type B	52542	T970900	T970900	4
		2	SCREW, Sheet Metal 6 × 5/8 Type B	52542	T970900	T970900	1
		3	WASHER, Mica	08289	TA-2402-A	10051	1
		1-3	TERMINAL	13150	72205-53	116877	1
		1-3	JUMPER, 2-Terminal	13150	7233/2	116878	2
		1-3	COVER, Protective	52547	065427	065427	Ref
		1-3	WASHER, Lock Int. Tooth #6	52542	T990220	T990220	2
		1-3	SPACER, Threaded #32	83330	8797	100827	2
		1-3	SCREW, PHM 6-32 × 3/4	96906	MS51957-32	10063212	2
		2, 3	SOCKET, Transistor	52542	830103	830103	1
		1-3	STANDOFF, MF	88245	1450B-11	100471	1
		1-3	LUG, Solder #6	52542	T960035	T960035	1

USED ON CODE: 1 = PHR20-12 2 = PHR50-8 3 = PHR100-4

REPLACEABLE PARTS LIST

TITLE **A1, AMPLIFIER PC ASSEMBLY REV A**

ITEM #	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
		1	ASSEMBLY, Amplifier, PC	52542	06557701	06557701	1
		2	ASSEMBLY, Amplifier, PC	52542	06557702	06557702	1
		3	ASSEMBLY, Amplifier, PC	52542	06557703	06557703	1
		1-3	BOARD, PC	52542	065577	065577	1
	C1	1-3	CAPACITOR, Mylar .0047μF 10%, 200V	56289	192P47292	100129	1
	C2	1	CAPACITOR, Mylar 1.0μF 20%, 200V	14752	210B1B105	100056	1
	C2	2,3	CAPACITOR, Mylar .47μF 20%, 200V	12406	ZD2A474	102584	1
	C3	1	CAPACITOR, Mylar .01μF 10%, 200V	56289	192P10392	100168	1
	C3	2,3	CAPACITOR, Mylar .0022μF 10%, 200V	56289	192P22292	100185	2
	C4	1	CAPACITOR, Mylar .001μF 10%, 200V	56289	192P10292	100137	1
	C4	2	Same as C3				
	C4	3	Not Used				
	C5	1-3	CAPACITOR, Mylar .003μF 10%, 100V	99515	D1-333E	100142	1
	C6	1-3	CAPACITOR, DM 150pF 5%, 500V	72136	DM15FD151JO	100219	1
	C7	1-3	CAPACITOR, DM 27pF 5%, 500V	72136	DM15ED270JO	102545	1
	C8	1-3	CAPACITOR, Mylar .0022μF 10%, 200V	56289	192P22292	100185	2
	C9	1	CAPACITOR, Ceramic .005μF 20%, 500V	91418	SM250	100077	1
	C9	2	CAPACITOR, Ceramic .0022μF 100V	72982	8121-100W5R222K	102623	1
	C9	3	CAPACITOR, DM .001μF 5%, 100V	72136	DM15FA102JO	100243	1
	C10	1-3	CAPACITOR, Tant 1.0μF 10%, 35V	56289	196D105X9035HA1	103716	1
	C11	1-3	CAPACITOR, Tant 56μF 10%, 6V	56289	150D566X9006B2	100225	2
	C12	1-3	CAPACITOR, Ceramic .01μF +80-20%, 100V	91418	BT .01 80/-20%	100103	1
	C13	1-3	Same as C8				

USED ON CODE: 1 = PHR20-12 2 = PHR50-8 3 = PHR100-4

REPLACEABLE PARTS LIST

TITLE **A1, AMPLIFIER PC ASSEMBLY REV A (Cont'd)**

ITEM #	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	C14	1, 2	CAPACITOR, DM 18pF 5%, 500V	72136	DM15CD180JO	100242	1
	C14	3	CAPACITOR, DM 30pF 5%, 500V	72136	DM15ED300JO	102546	1
	C15	1-3	Same as C11				
	C16	1-3	CAPACITOR, Tant 15μF 10%, 20V	56289	150D156X9020B2	100211	3
	C17	1-3	CAPACITOR, El Ax 470μF 40V	99392	ET471X040A02	103383	1
	C18	1-3	Same as C16				
	C19	1-3	Same as C16				
	C20	1, 2	CAPACITOR, DM 330pF 5%, 500V	72136	DM15FD331JO	100276	2
	C20	3	CAPACITOR, DM 300pF 5%, 500V	72136	DM15FD331JO	100276	1
	C21	3	Same as C20				
	CR1	1-3	DIODE, Signal 50V	03508	1N4151	100385	15
	CR2	1-3	Same as CR1				
	CR3	1-3	DIODE, Signal 125V	13715	FDH300	102703	2
	CR4	1-3	Same as CR1				
	CR5	1-3	DIODE, Zener 6.8V	04713	1N957B	100416	3
	CR6-CR8	1-3	Same as CR1				
	CR9	1-3	DIODE, Zener 10V	04713	1N961B	100395	2
	CR10-CR18	1-3	Same as CR1				
	CR19	1-3	DIODE, Zener 15V	04713	1N965B	100383	1
	CR20	1-3	DIODE, Rectifier 400V	04713	1N5395	100413	4
	CR21	1-3	Same as CR5				
	CR22	1-3	DIODE, Zener 6.2V	04713	1N823	720461	1
	CR23-CR25	1-3	Same as CR20				
	CR26	1-3	Same as CR5				
	CR27	1-3	Same as CR9				
	CR28	1-3	DIODE, Reference 6.4V	04713	1N4567A	117339	1
	CR29	1-3	DIODE, Zener 5.6V	03877	1N752A	100376	1
	CR30	1-3	Same as CR3				

USED ON CODE: 1 = PHR20-12 2 = PHR50-8 3 = PHR100-4

REPLACEABLE PARTS LIST

TITLE **A1, AMPLIFIER PC ASSEMBLY REV A (Cont'd)**

ITEM #	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	J3	1-3	SOCKET, IC 16-pin	73803	C8816-01	117041	2
	Q1	1	TRANSISTOR, SINPN 30V	07263	PN3643-5	101358	2
	Q1	2	TRANSISTOR, SINPN 60V	07263	PN3568-5	101359	1
	Q1	3	TRANSISTOR, SINPN 160V	07263	2N5831	102676	1
	Q2	1	TRANSISTOR, SIPNP 60V	04713	2N2905AS	705067	3
	Q2	2, 3	TRANSISTOR, SIPNP 150V	04713	MM4001	705066	2
	Q3	1	Same as Q2				
	Q3	2	TRANSISTOR, SIPNP 60V	04713	2N2905AS	705067	1
	Q3	3	TRANSISTOR, SIPNP 300V	04713	MPS-A92	700179	1
	Q4	2, 3	Same as Q2				
	Q5	1-3	TRANSISTOR, JFETN-Channel 50V	27014	2N4340	705069	1
	Q6	1	Same as Q1				
	Q6	2, 3	TRANSISTOR, SINPN 30V	07263	PN3643-5	101358	1
	Q7-Q10	1-3	TRANSISTOR, SINPN 40V	04713	2N3906	101378	4
	R1	1-3	RESISTOR, MF 1.0K 1%, 1/8W	19701	MF5C-D-1001F	102097	1
	R2	1-3	RESISTOR, MF 4.87K 1%, 1/8W	81349	RN60E4871F	117776	2
	R3	1	RESISTOR, MF 20.0K 1%, 1/8W	91637	MFF 1/8 T9	103015	1
	R3	2	RESISTOR, MF 49.9K 1%, 1/8W	81349	RN60E4992F	102296	1
	R3	3	RESISTOR, MF 100K 1%, 1/4W	81349	RN65E1003F	117653	1
	R4	1-3	RESISTOR, MF 14.0K 1%, 1/8W	91637	CMF60	103432	1
	R5	1-3	Same as R2				
	R6	1-3	RESISTOR, Variable 500 Ω 10%, 3/8W	73138	89PR500	102183	1
	R7	1-3	RESISTOR, Variable 2K 10%, 3/8W	73138	89PR2K	102119	1
	R8	1-3	RESISTOR, Variable 10K 10%, 3/8W	73138	89PR10K	102472	1
	R9	1-3	RESISTOR, MF 3.16K 1%, 1/8W	91637	MFF 1/8 T1	102197	1
	R10	1-3	RESISTOR, MF 5.76K 1%, 1/8W	91637	CMF60 T2	103424	1
	R11	1	RESISTOR, MF 11.8K 1%, 1/8W	91637	MFF 1/8 T1	106215	1
	R11	2	RESISTOR, MF 13.3K 1%, .13W	81349	RN60D1332F	117173	1
	R11	3	RESISTOR, MF 14K 1%, 1/8W	91637	CMF60	103432	1
	R12	1-3	RESISTOR, MF 4.99K 1%, 1/8W	91637	MFF 1/8 T1	102079	1
	R13	1-3	RESISTOR, CC 10M 5%, 1/8W	01121	CB1065	101564	2
	R14	1-3	RESISTOR, CC 6.8K 5%, 1/4W	01121	CB6825	101544	4
	R15	1-3	RESISTOR, CC 2.4M 5%, 1/4W	01121	CB2455	106002	2

USED ON CODE: 1 = PHR20-12 2 = PHR50-8 3 = PHR100-4

REPLACEABLE PARTS LIST

TITLE **A1, AMPLIFIER PC ASSEMBLY REV A (Cont'd)**

ITEM #	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	R16	1-3	RESISTOR, CC 510 Ω 5%, 1/4W	01121	CB5115	101616	2
	R17	1-3	RESISTOR, CC 22K 5%, 1/4W	01121	CB2235	101572	4
	R18	1	RESISTOR, CC 10 Ω 5%, 1/4W	01121	CB1505	101764	1
	R18	2	RESISTOR, CC 51 Ω 5%, 1/4W	01121	CB5105	101672	1
	R18	3	RESISTOR, CC 82 Ω 5%, 1/4W	01121	CB8205	101629	1
	R19	1-3	RESISTOR, CC 47K 5%, 1/4W	01121	CB4735	101574	1
	R20	1-3	Same as R16				
	R21	1-3	RESISTOR, CC 47 Ω 5%, 1/4W	01121	CB4705	101560	1
	R22	1-3	RESISTOR, CC10K 5%, 1/4W	01121	CB1035	101570	3
	R23	1-3	RESISTOR, CC 6.2K 5%, 1/4W	01121	CB6225	101608	1
	R24	1-3	RESISTOR, CC 820 Ω 5%, 1/4W	01121	CB8215	101567	1
	R25	1-3	RESISTOR, MF 10.0K .1%, 1/8W	81349	RN60C	106363	1
	R26	1	RESISTOR, MF 20.0K .1%, 1/8W	81349	RN60C	117663	1
	R26	2	RESISTOR, MF 50.0K .1%, 1/8W	81349	RN60C	106356	1
	R26	3	RESISTOR, MF 100K .1%, 1/8W	91637	CMF60 T9	103423	1
	R27	1-3	Same as R22				
	R28	1-3	RESISTOR, CC 1K 5%, 1/4W	01121	CB1025	101569	1
	R29	1-3	RESISTOR, MF 31.6K 1%, 1/8W	19701	MF5C-D-3162F	102941	1
	R30	1-3	RESISTOR, MF 499 Ω 1%, 1/8W	16299	NA60	106250	1
	R31	1	RESISTOR, WW .01 Ω 3%, 5W	15915	TSK5 .01 3%	117658	1
	R31	2	RESISTOR, WW .017 Ω 3%, 5W	15915	TSK5 .017 3%	117659	1
	R31	3	RESISTOR, WW .033 Ω 3%, 5W	15915	TSK5 .033 3%	117660	1
	R32	1-3	Same as R22				
	R33	1-3	RESISTOR, CC 1.2K 5%, 1/4W	01121	CB1225	101581	1
	R34	1	RESISTOR, MF 110 Ω 1%, 1/8W	81349	RN60D1100F	116603	1
	R34	2, 3	RESISTOR, MF 124 Ω 1%	81349	RN60D1240F	116875	1
	R35	1-3	RESISTOR, Variable 20 Ω 10%, 3/8W	73138	89PR20	102154	1
	R36	1-3	Same as R13				
	R37	1-3	RESISTOR, Variable 1K 10%, 3/8W	73138	89PR1K	102181	1
	R38	1-3	RESISTOR, Variable 50K 10%, 3/8W	73138	89PR50K	102153	1
	R39	1-3	Same as R15				
	R40-R44	1-3	RESISTOR, CC 1.5K 5%, 1/4W	01121	CB1525	101577	5

USED ON CODE: 1 = PHR20-12 2 = PHR50-8 3 = PHR100-4

REPLACEABLE PARTS LIST

TITLE **A1, AMPLIFIER PC ASSEMBLY REV A (Cont'd)**

ITEM #	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	R45	1-3	RESISTOR, Variable 100Ω 10%, 3/8W	73138	89PR100	102240	1
	R46	1-3	RESISTOR, CC 100K 5%, 1/4W	01121	CB1045	101558	1
	R47-R49	1-3	Same as R14				
	R50-R52	1-3	Same as R17				
	R53	1-3	RESISTOR, CC 2.7K 5%, 1/2W	01121	EB2725	101436	1
	R54	1-3	RESISTOR, MF 16.9K 1%, .1W	81349	RN55C1692F	117907	2
	R55	1-3	RESISTOR, MF 10.0K 1%, 1/8W	19701	MF5C-D-1002-F	102098	1
	R56	1-3	RESISTOR, MF 22.6K 1%, 1/8W	19701	MF5C-D-2262-F	102140	1
	R57	1-3	Same as R54				
	R58	1-3	RESISTOR, CC 2.2K 5%, 1/4W	01121	CB2225	101562	1
	R59	1-3	JUMPER				1
	S1-S3	1-3	SWITCH, Pushbutton 20V	95146	TSS21NG-RA	117664	3
	U1	1-3	IC, Op Amp	27014	LM201AH	025758	1
	U1	1-3	IC, Op Amp	07263	LM747HC	103708	1
	U1	1-3	IC, Op Amp	27014	LM301AH	025745	2
	U4	1-3	Same as U3				
	U5	1-3	IC, Opto Isolator	50522	MCT6	102858	2
	U6	1-3	Same as U5				
	XU5, 6	1-3	Same as J3				

USED ON CODE: 1 = PHR20-12 2 = PHR50-8 3 = PHR100-4

REPLACEABLE PARTS LIST

TITLE **A2, PRE-REGULATOR PC ASSEMBLY REV B**

ITEM #	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
		1	ASSEMBLY, Pre-Regulator PC	52542	06557601	06557601	Ref
		2	ASSEMBLY, Pre-Regulator PC	52542	06557602	06557602	Ref
		3	ASSEMBLY, Pre-Regulator PC	52542	06557603	06557603	Ref
		1-3	BOARD, PC	52542	065576	065576	1
	C1	1-3	CAPACITOR, Ceramic 1.0μF 10%, 100V	56289	5CZ5U105X0050C5	100176	1
	C2	1, 3	CAPACITOR, Metal Mylar .22μF 10%, 100V	99515	DE1-224	100148	1
	C2	2	CAPACITOR, Metal Mylar .22μF 10%, 100V	99515	DE1-224	100148	2
	C3	1	CAPACITOR, Tant 1.0μF 10%, 35V	56289	150D105X9035A2	100082	1
	C3	2	CAPACITOR, Tant 3.3μF 10%, 35V	56289	150D335X9035B2	106528	1
	C3	3	CAPACITOR, Tant 6.8μF 10%, 35V	56289	150D685X9035B	100082	1
	C4	1	CAPACITOR, Metal Mylar .47μF 20%, 100V	99515	D1-474	100061	1
	C4	2	Same as C2				
	C4	3	CAPACITOR, Metal Mylar 0.1μF 10%, 100V	91515	DE1-104E	100141	1
	C5	3	CAPACITOR, Mylar .022μF 10%, 80V	56289	192P2249R8	103494	1
	C6	1-3	CAPACITOR, Metal Mylar .047μF 50V	52763	MKT1813-347/2	100157	1
	CR1-CR4	1-3	DIODE, Rectifier 400V	04713	1N5395	100413	5
	CR5	1, 2	DIODE, Zener 6V	03877	1N752A	100376	1
	CR5	3	DIODE, Zener 6V	03877	1N752A	100376	2
	CR6	1-3	DIODE, Zener 2V	04713	1N959B	100429	1
	CR7	1-3	DIODE, Zener 16V	04713	1N966B	100398	1
	CR8	1-3	DIODE, Signal 50V	03508	1N4151	100385	2
	CR9	2, 3	DIODE, Zener 27V	04713	1N971B	100402	1
	CR10	1, 2	JUMPER		L-2007-1	102879	1
	CR10	3	Same as CR5				
	CR11	1-3	Same as CR1				
	CR12	1-3	Same as CR8				

USED ON CODE: 1 = PHR20-12 2 = PHR50-8 3 = PHR100-4

REPLACEABLE PARTS LIST

TITLE **A2, PRE-REGULATOR PC ASSEMBLY REV B (Cont'd)**

ITEM #	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	Q1	1-3	TRANSISTOR, SIPNP 60V	07263	PN4250-18	102725	1
	Q2	1-3	TRANSISTOR, Selected Uni-Junction	52542	720145	720145	1
	Q3	1-3	TRANSISTOR, NPN	02735	2N2714	700180	1
	R1	1-3	RESISTOR, CC 680K 5%, 1/2W	01121	EB6815	101475	1
	R2	1-3	RESISTOR, Variable 20K 10%, 3/8W	73138	89PR20K	102470	1
	R3	1	RESISTOR, MF 100K 1%, 1/8W	91637	MFF 1/8 T1	102080	1
	R3	2	RESISTOR, CC 82K 5%, 1/4W	01121	CB8235	101578	1
	R3	3	RESISTOR, MF 121K 1%	16299	NA60	106216	1
	R4	1-3	RESISTOR, MF 6.81K 1%, 1/8W	91637	MFF 1/8	102118	1
	R5	1-3	RESISTOR, MF 10K 1%, 1/8W	19701	MF5C-D-1002-F	102098	1
	R6	1	RESISTOR, MF 200K 1%, 1/8W	19701	MF5C-D-2003-F	102083	1
	R6	2	RESISTOR, MF 499K 1%, .1W	19701	5053YD4993F	101908	1
	R6	3	RESISTOR, MF 1M 5%, 1/4W	01121	CB1055	101605	1
	R7	1-3	RESISTOR, MF 4.99K 1%, 1/8W	91637	MFF 1/8 T1	102079	1
	R8	1	RESISTOR, MF 15K 1%	19701	MFSC-D-1502-F	101843	2
	R8	2	RESISTOR, MF 30.1K 1%	81349	RN60D3012F	106318	1
	R8	3	RESISTOR, MF 37.4K 1%	1970	MF5C-D-3742-F	102145	1
	R9	1	Same as R8				
	R9	2, 3	RESISTOR, MF 15K 1%, 1/8W	19701	MF5C-D-1502-F	101843	1
	R10	1-3	RESISTOR, CC 10Ω 5%, 1/4W	01121	CB1005	101557	3
	R11	1-3	Same as R10				
	R12	1-3	RESISTOR, CC 100Ω 5%, 1/4W	01121	CB1015	101609	1
	R13	1	RESISTOR, MF 255K 1%	81349	RN60C2553F	106177	1
	R13	2	RESISTOR, MF 620K 5%, 1/4W	01121	CB6245	101619	1

USED ON CODE: 1 = PHR20-12 2 = PHR50-8 3 = PHR100-4

REPLACEABLE PARTS LIST

TITLE **A2, PRE-REGULATOR PC ASSEMBLY REV B (Cont'd)**

ITEM #	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	R13	3	RESISTOR, MF 1.2M 1%, 1/4W	01121	CB1255	101684	1
	R14	1-3	Same as R10				
	R15	1-3	RESISTOR, CC 820Ω 5%, 1/4W	01121	CB8215	101567	1
	TP1		TEST POINT	91833	1540-2	T960464	
	TP2		Same as TP1				

USED ON CODE: 1 = PHR20-12 2 = PHR50-8 3 = PHR100-4

REPLACEABLE PARTS LIST

TITLE **A3, INDICATOR PC ASSEMBLY REV A**

ITEM #	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
		1	ASSEMBLY, Indicator PC	52542	06558701	06558701	1
		2	ASSEMBLY, Indicator PC	52542	06558702	06558702	1
		3	ASSEMBLY, Indicator PC	52542	06558703	06558703	1
		1-3	BOARD, PC	52542	065587	065587	1
	DS1	1-3	LED, Green	50522	MV5253 W/MTGGRM	103202	1
	DS4	1-3	LED, Red	50522	MV5754	103960	1
	DS2, DS3	1-3	LED, Orange	50522	MV5153 W/M	103201	2
	DS5-DS7	1-3	LED, Green 2.4V	50522	LD37-1	116601	3
	R1	1-3	RESISTOR, Variable 10K 10%, 1/2W	80294	68WR10K	117399	1
	R2	1	RESISTOR, MF 18.2K 1%, 1/8W	19701	MF5C-D-1822F	102139	1
	R2	2	RESISTOR, MF 47.5K 1%, 1/8W	81349	RN60C4752F	106189	1
	R2	3	RESISTOR, MF 95.3K 1%, 1/8W	81349	RN60D9532F	116602	1
	R3	1, 2	RESISTOR, Variable 5K 10%, 3/8W	73138	72PR5K	103788	1
	R3	3	RESISTOR, Variable 10K 10%, 3/8W	73138	72PR10K	103789	1
	R4	1-3	RESISTOR, MF 33.2 Ω 1%, .1W	81349	RN55D33R2F	117588	1
		1-3	FIXTURE	52542	065631	065631	1
		1-3	ASSEMBLY, Cable	52542	065655	065655	1

USED ON CODE: 1 = PHR20-12 2 = PHR50-8 3 = PHR100-4

CHAPTER 6

DRAWINGS

6-1. INTRODUCTION

6-2. This chapter contains final assembly and schematic drawings for the PHR Series Power Supplies. The schematic diagrams relate to the detailed circuit descriptions in this manual. The parts list contained in Chapter 5 relates to the reference designation callouts in the diagrams. Table 6-1 provides a list by figure number of the drawings, with title, drawing number and manual page number.

Table 6-1. List of Drawings

Figure No.	Drawing Title	Drawing No.	Page No.
6-1	PHR Series Cover Assembly	06526701	6-3
6-2	PHR20-12 and PHR50-8 Chassis Assembly	06559601	6-4
6-3	PHR100-4 Chassis Assembly	06559603	6-5
6-4	PHR20-12 Heatsink Assembly	06558501	6-6
6-5	PHR50-8 and PHR100-4 Heatsink Assembly	06558502	6-6
6-6	PHR Series Front Panel Assembly	06558101	6-7
6-7	PHR20-12 Rear Panel Assembly	06558301	6-8
6-8	PHR50-8 Rear Panel Assembly	06558302	6-9
6-9	PHR100-4 Rear Panel Assembly	06558303	6-10
6-10	PHR Series, A1, Amplifier PC Assembly	065577	6-11
6-11	PHR Series, A2, Pre-Regulator PC Assembly	065576	6-12
6-12	PHR20-12, A2, Pre-Regulator Schematic	7-06557601	6-13
6-13	PHR50-8, A2, Pre-Regulator Schematic	7-06557602	6-14
6-14	PHR100-4, A2, Pre-Regulator Schematic	7-06557603	6-15
6-15	PHR Series, A3, Indicator PC Assembly	065587	6-16
6-16	PHR20-12 Schematic	06557801	6-17
6-17	PHR50-8 Schematic	06557802	6-18
6-18	PHR100-4 Schematic	06557803	6-19

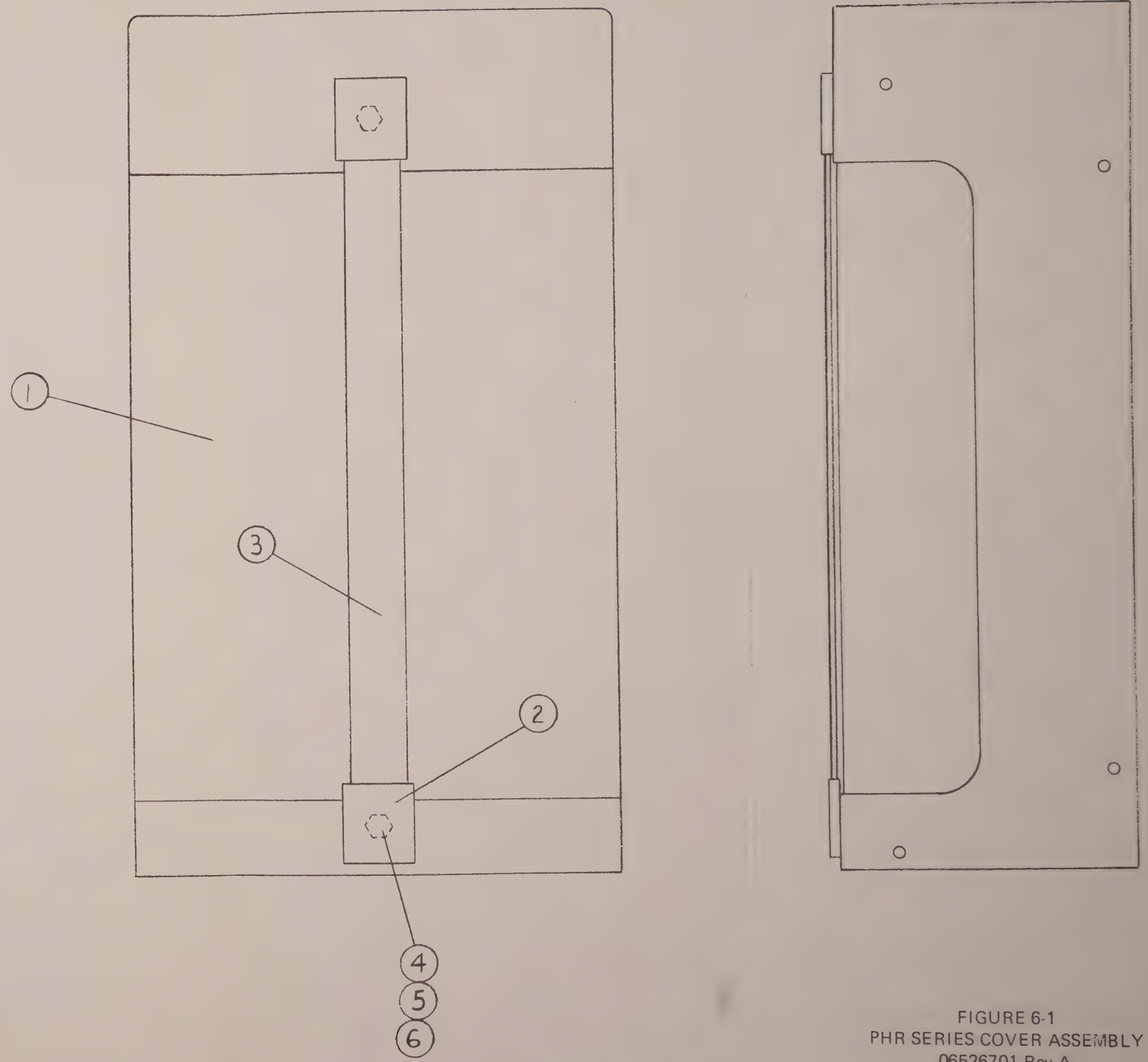
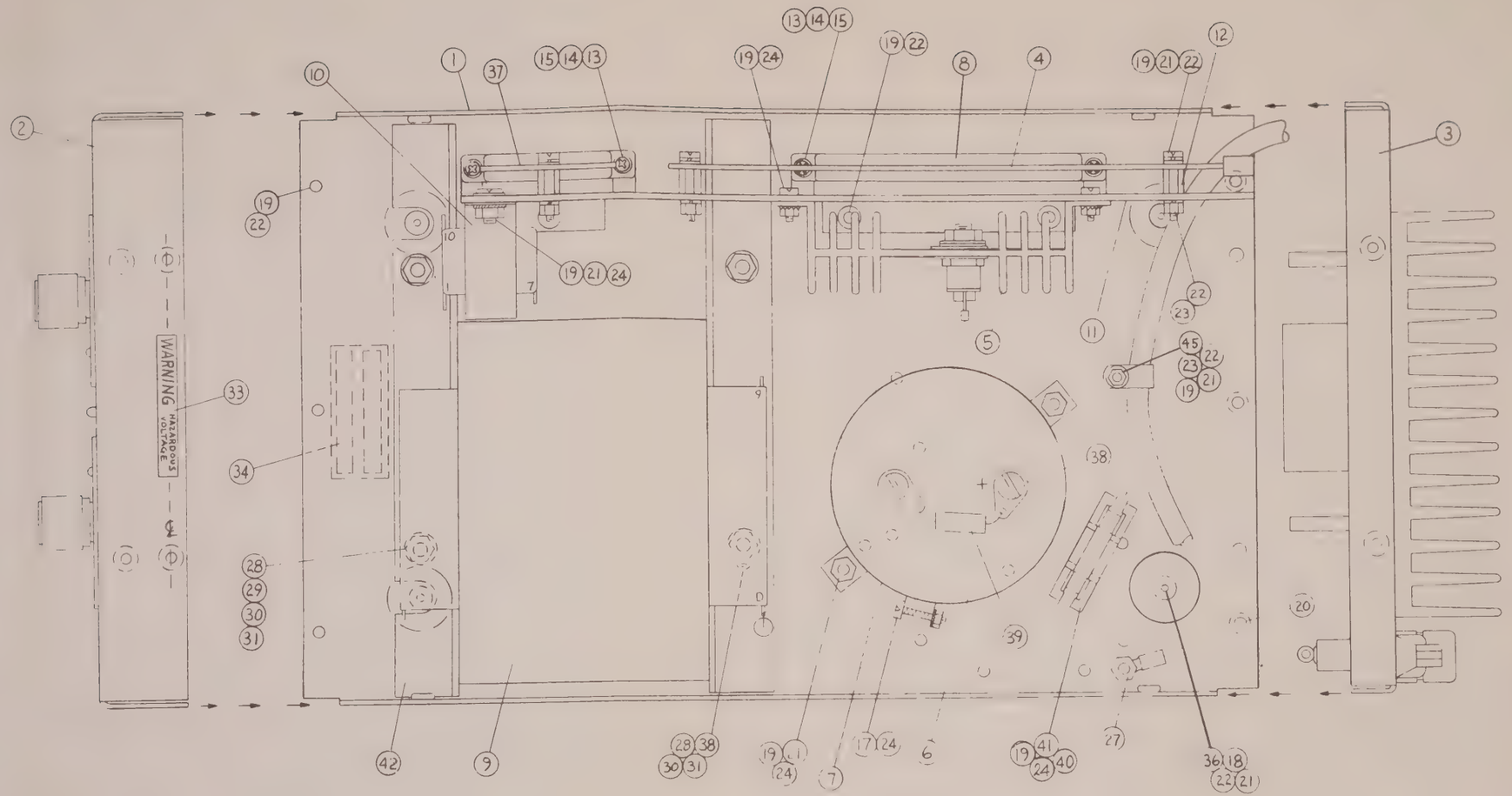
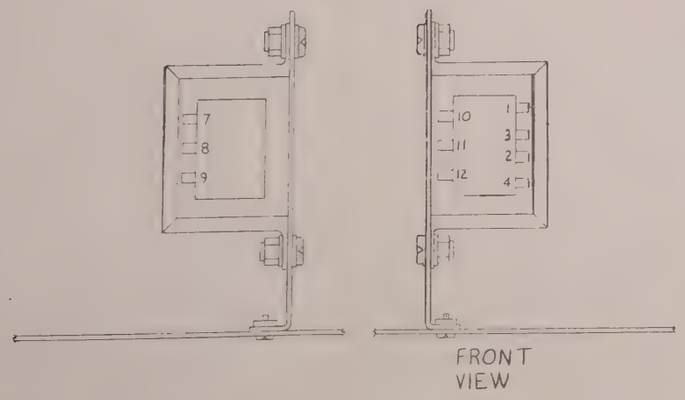
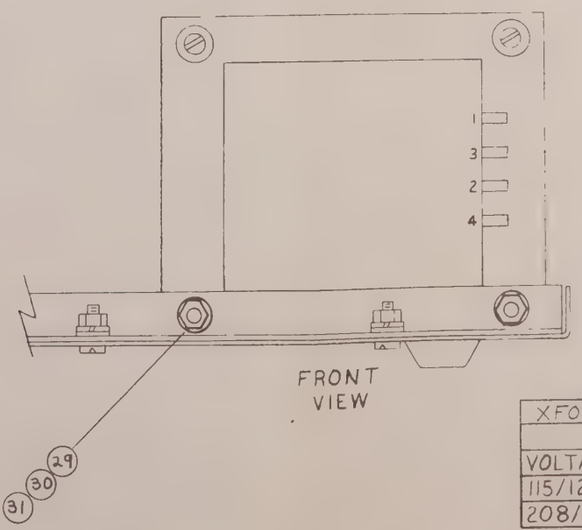
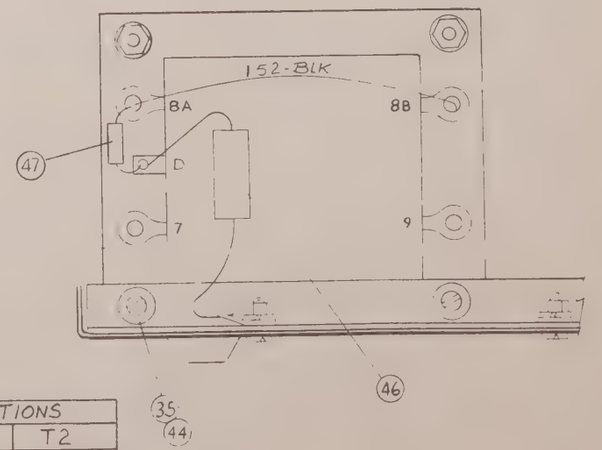


FIGURE 6-1
PHR SERIES COVER ASSEMBLY
06526701 Rev A



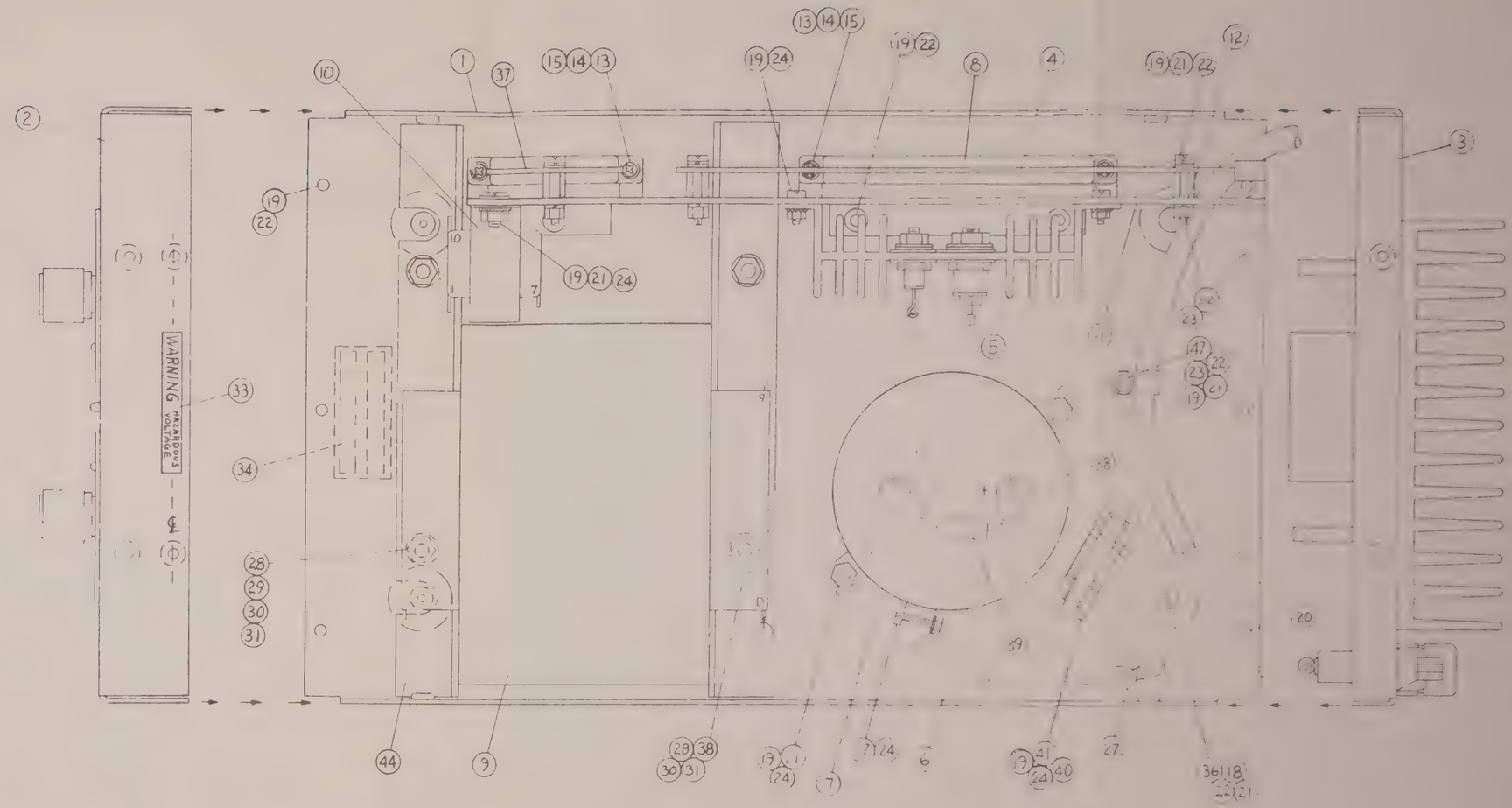


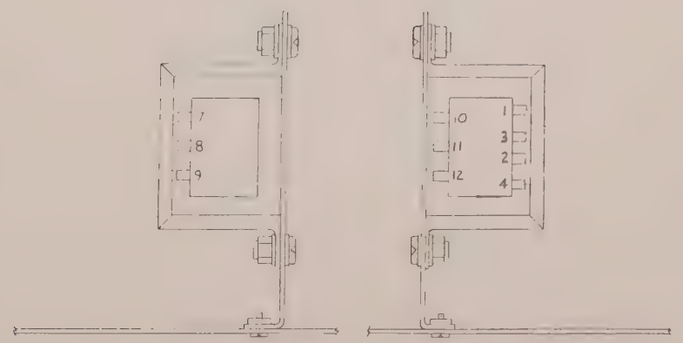


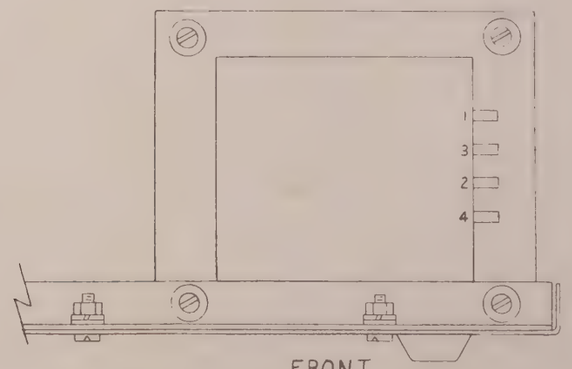


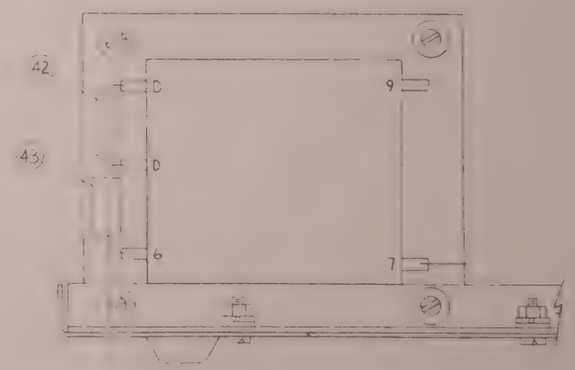
XFORMER CONNECTIONS		
	T1	T2
VOLTAGE	JUMPERS	JUMPERS
115/120	1-3, 2-4	1-3, 2-4
208/240	2-3	2-3

FIGURE 6-2
PHR20-12 & PHR50-8 CHASSIS ASSEMBLY
06559601 Rev A









XFORMER CONNECTIONS		
	T1	T2
VOLTAGE	JUMPERS	JUMPERS
115/120	1-3, 2-4	1-3, 2-4
208/240	2-3	2-3

FIGURE 6-3
PHR100-4 CHASSIS ASSEMBLY
06559603 Rev A

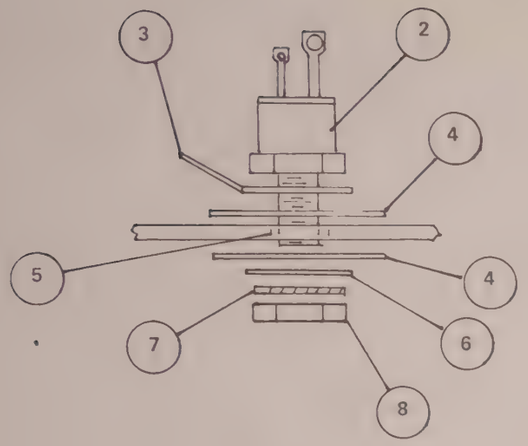
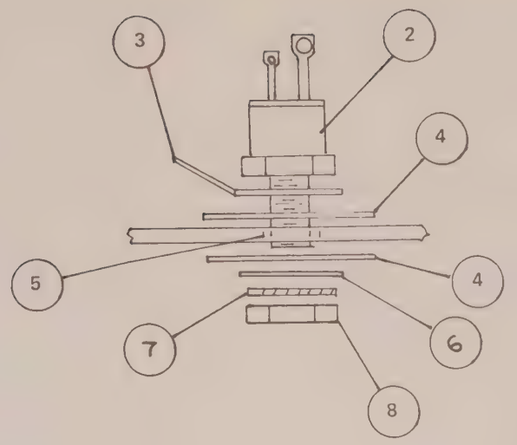
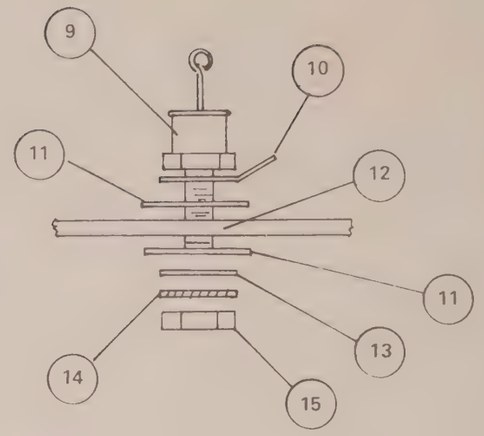
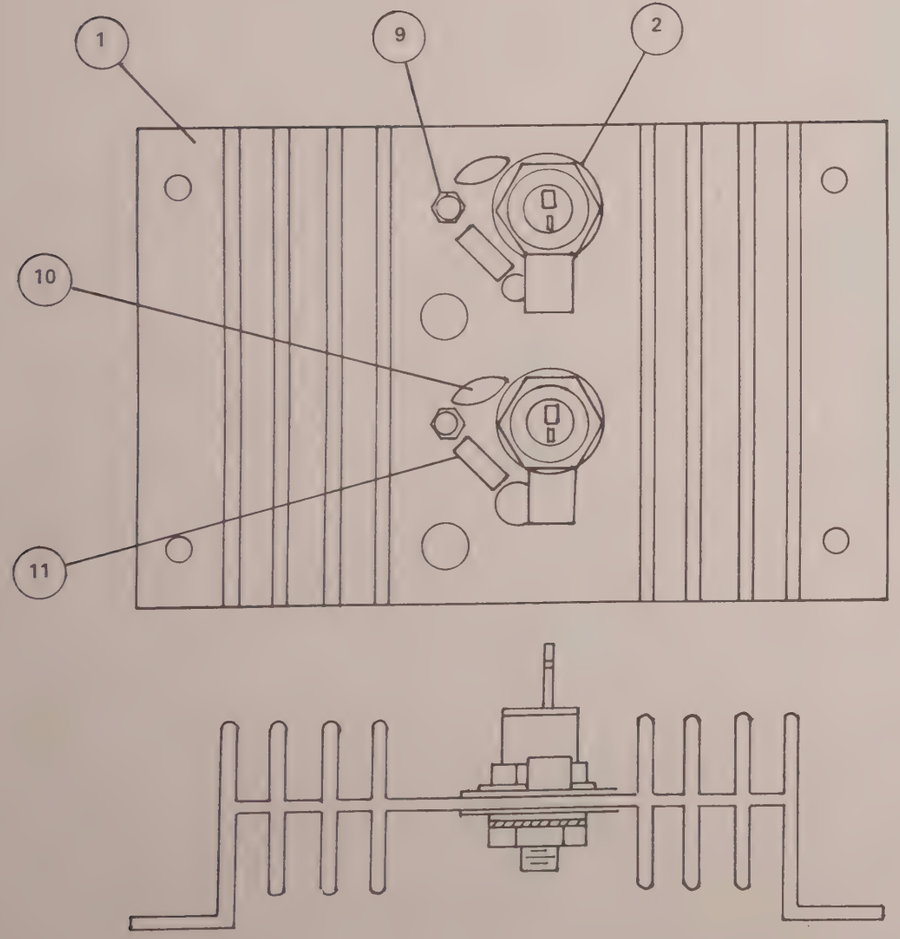


FIGURE 6-4
PHR20-12 HEATSINK ASSEMBLY
06558501 Rev A







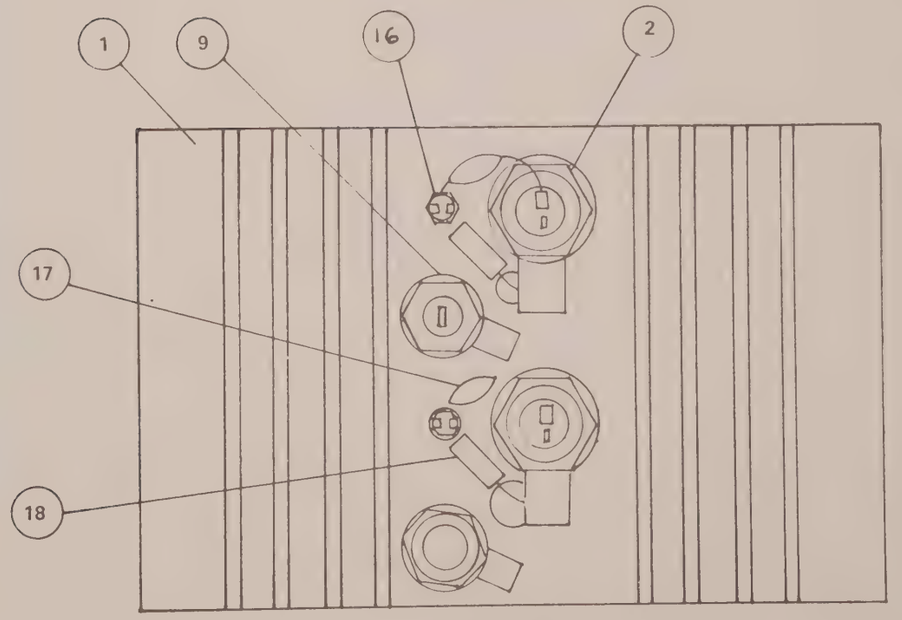
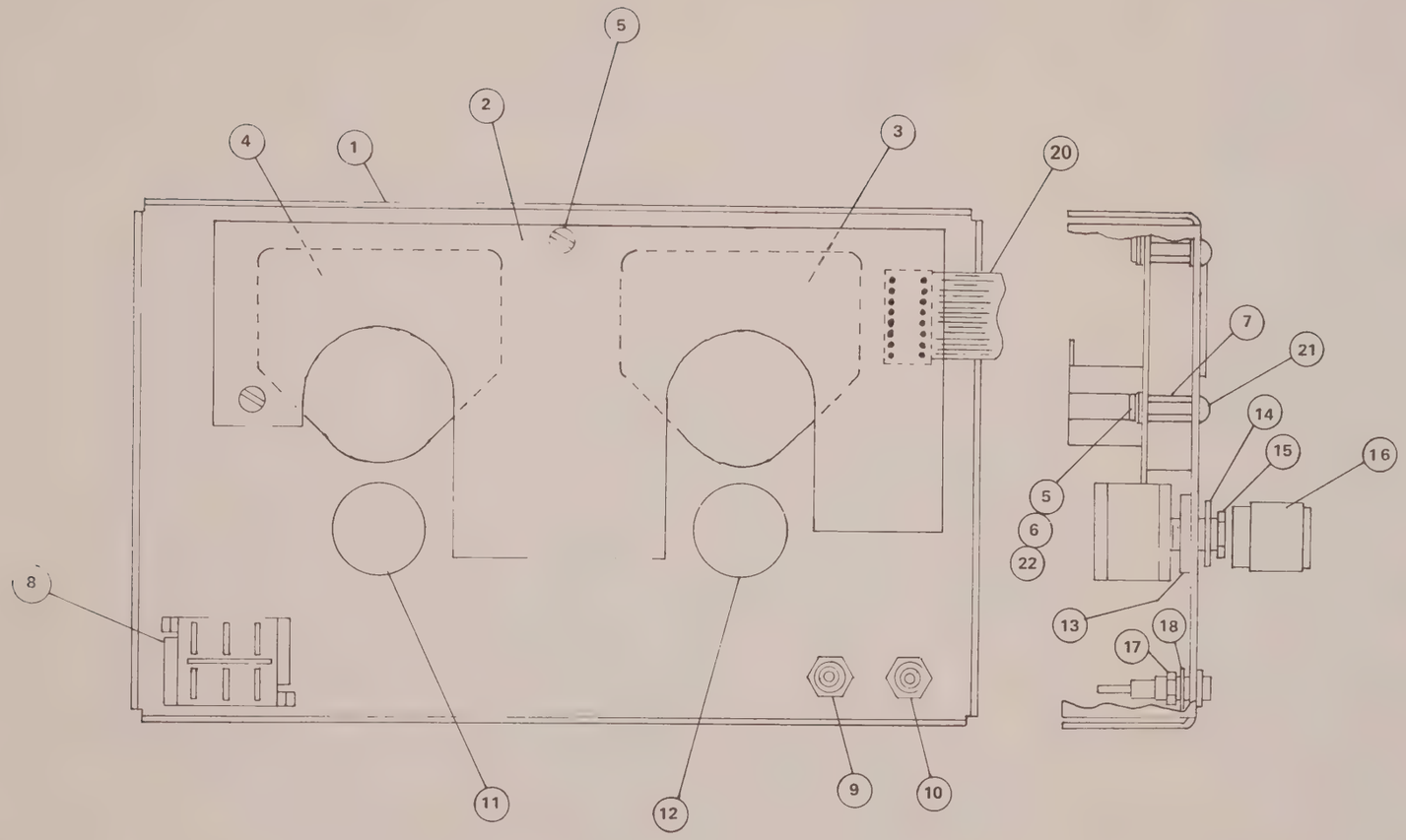


FIGURE 6-5
PHR50-8 & PHR100-4 HEATSINK ASSEMBLY
06558502 Rev A



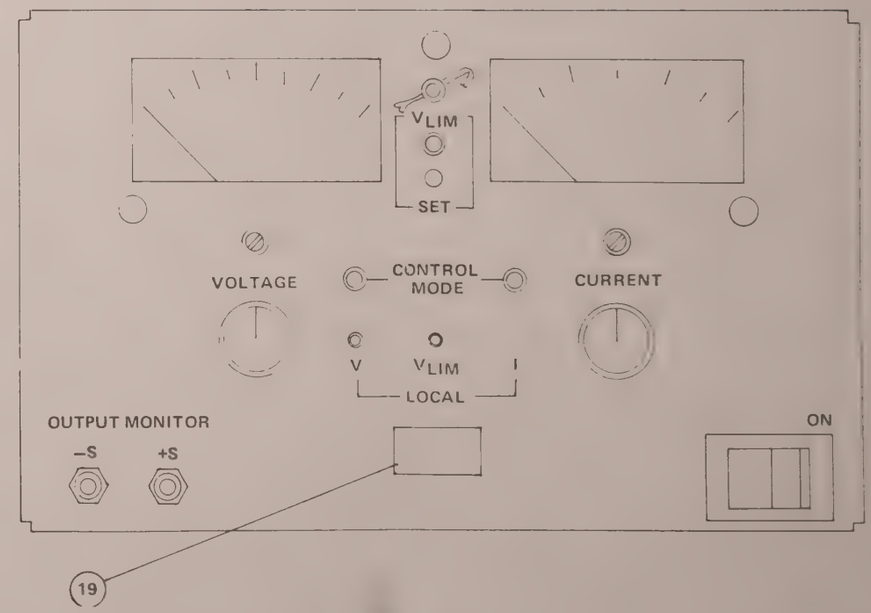


FIGURE 6-6
PHR SERIES FRONT PANEL ASSEMBLY
06558101 Rev A

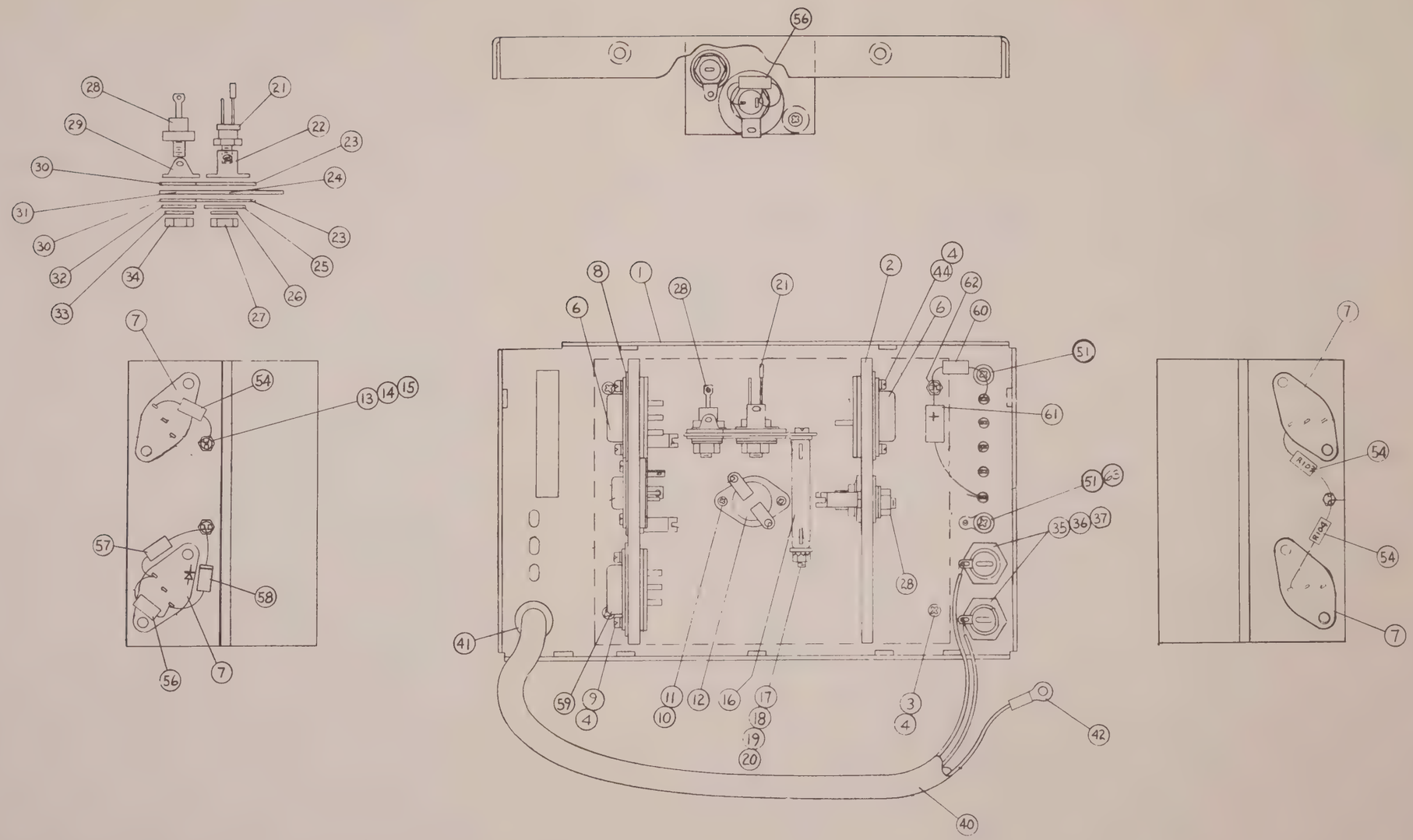


FIGURE 6-7
PHR20-12 REAR PANEL ASSEMBLY
06558301 Rev A

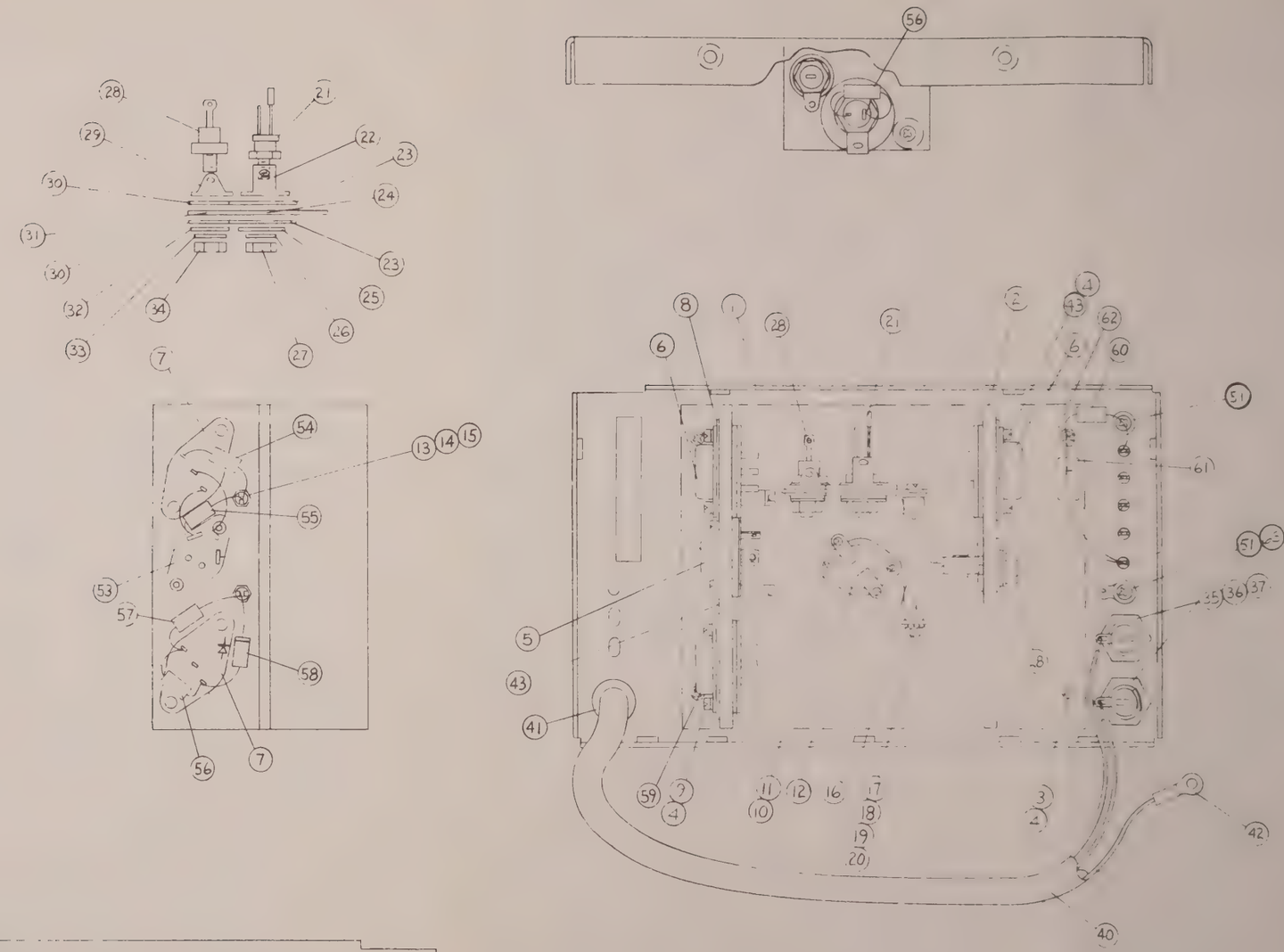


FIGURE 6-8
PHR50-8 REAR PANEL ASSEMBLY
06558302 Rev A

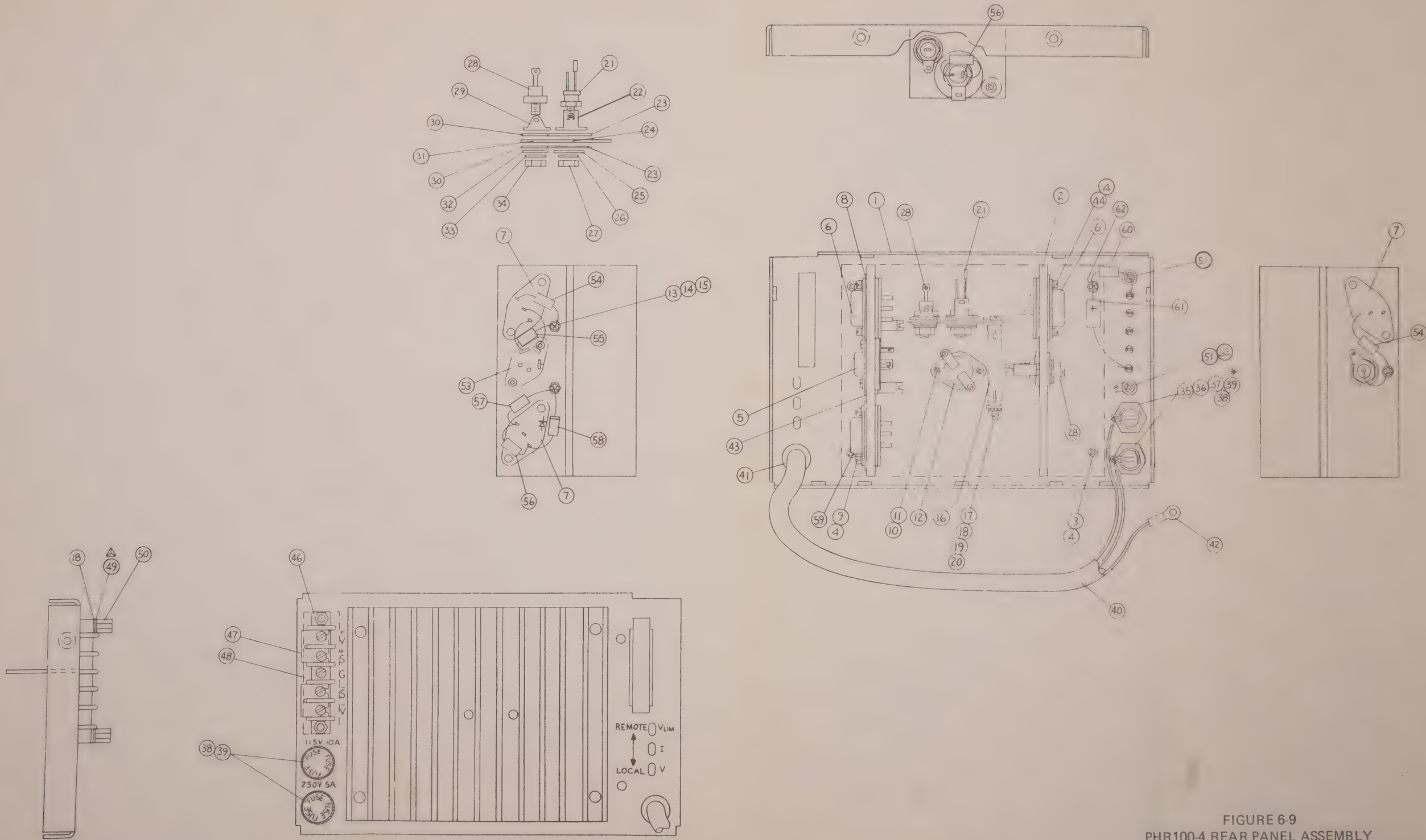


FIGURE 6-9
PHR100-4 REAR PANEL ASSEMBLY
03558303 Rev A

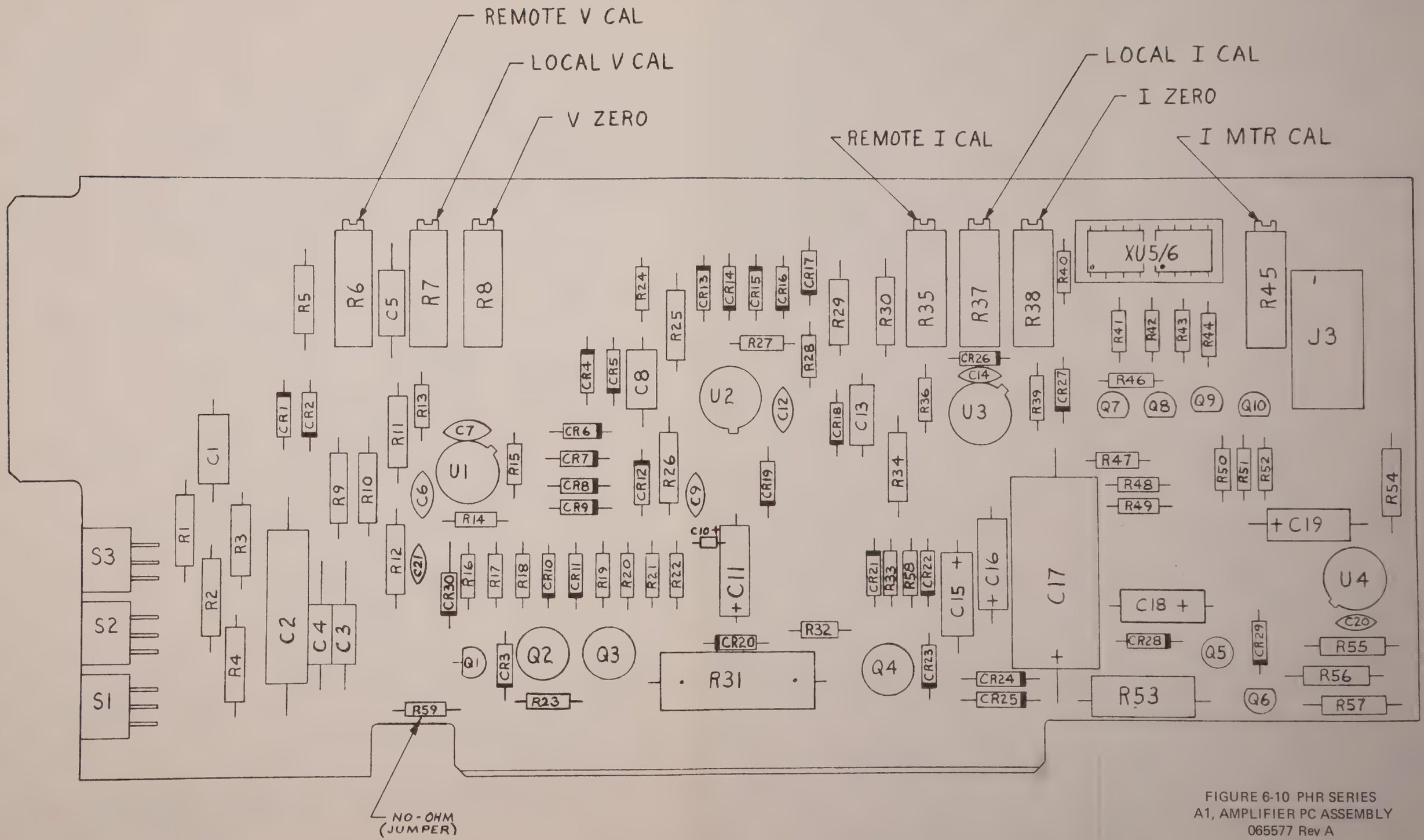


FIGURE 6-10 PHR SERIES
A1, AMPLIFIER PC ASSEMBLY
065577 Rev A

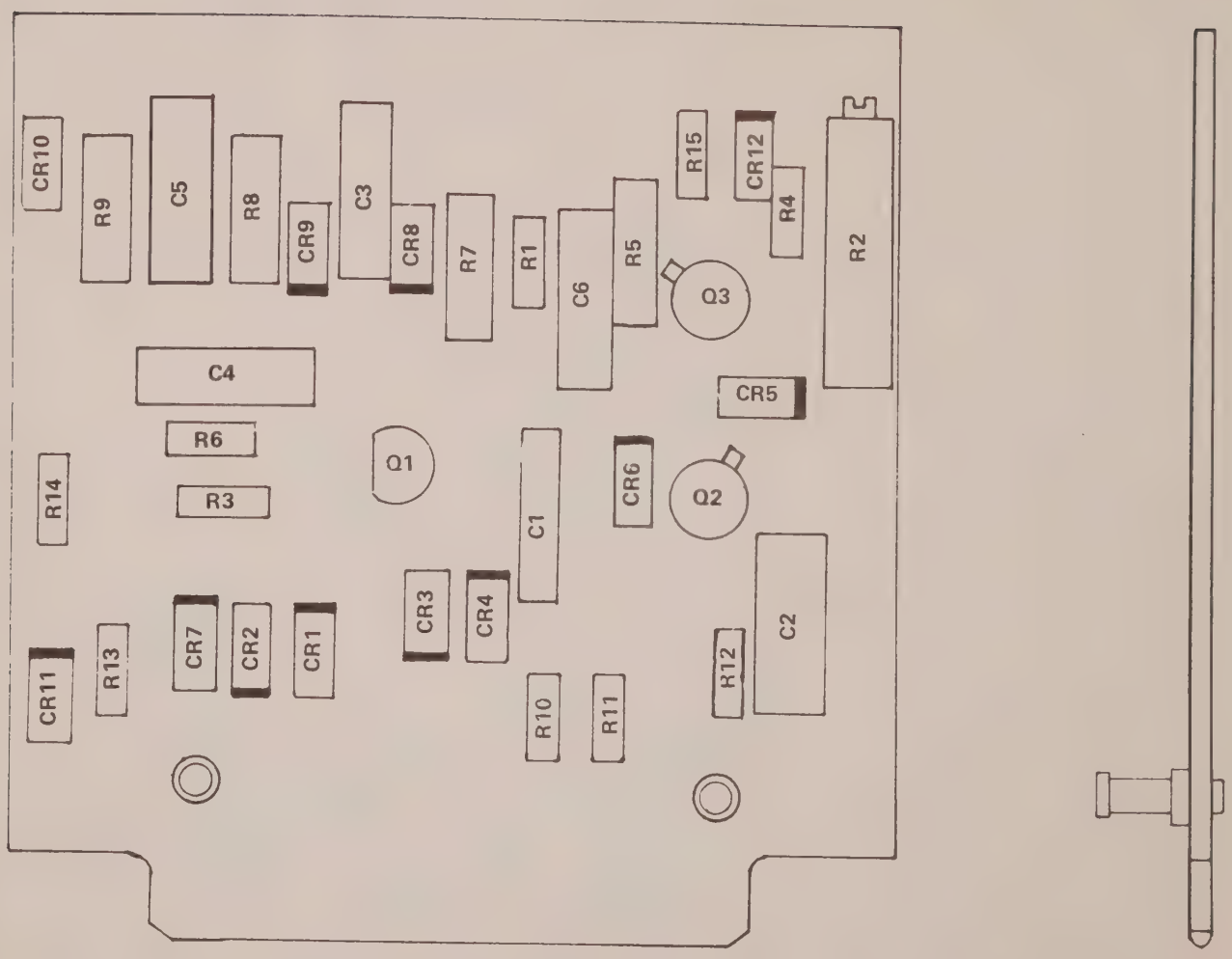


FIGURE 6-11 PHR SERIES
A2, PRE-REGULATOR PC ASSEMBLY
065576 Rev B

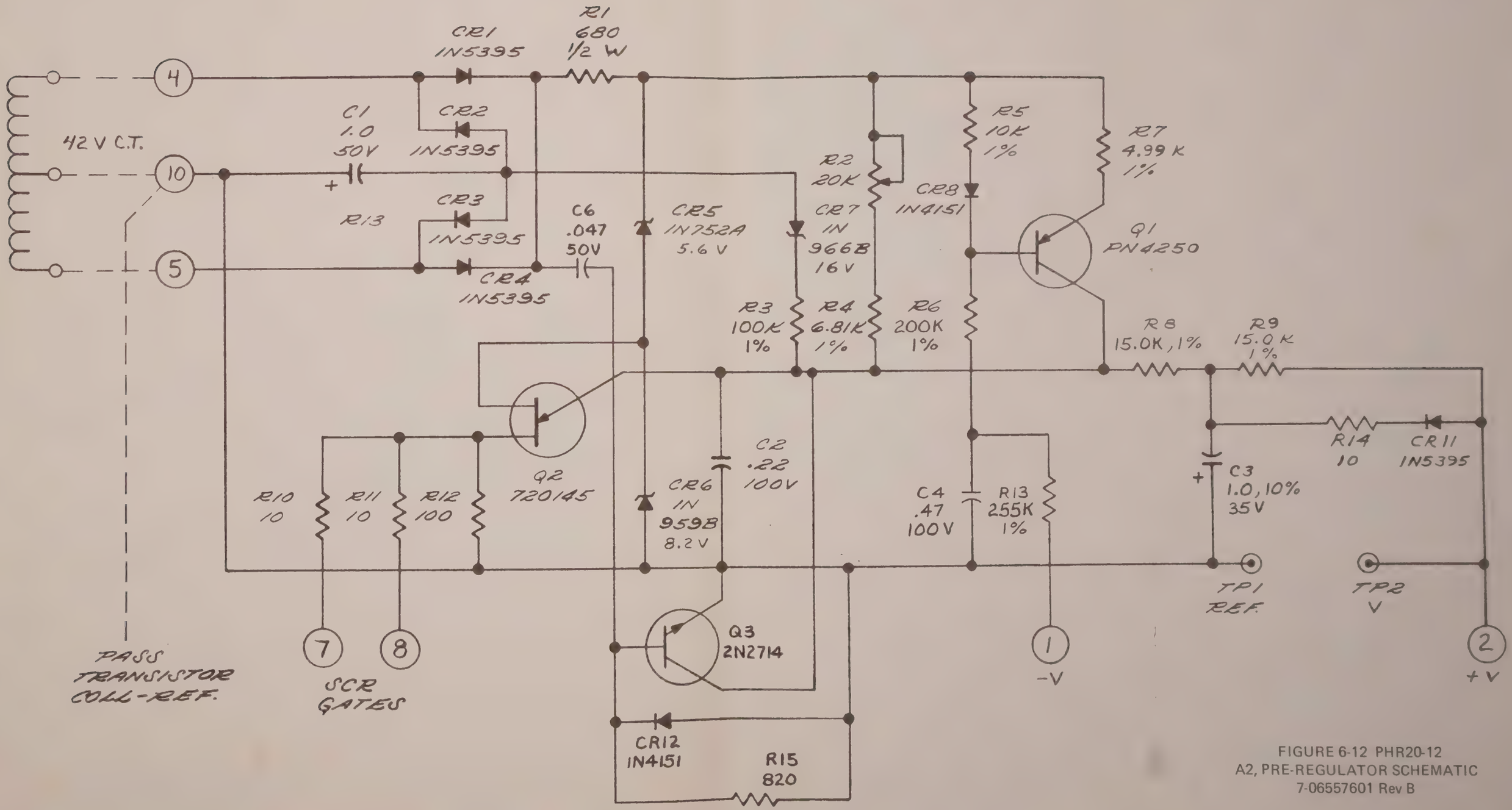


FIGURE 6-12 PHR20-12
A2, PRE-REGULATOR SCHEMATIC
7-06557601 Rev B

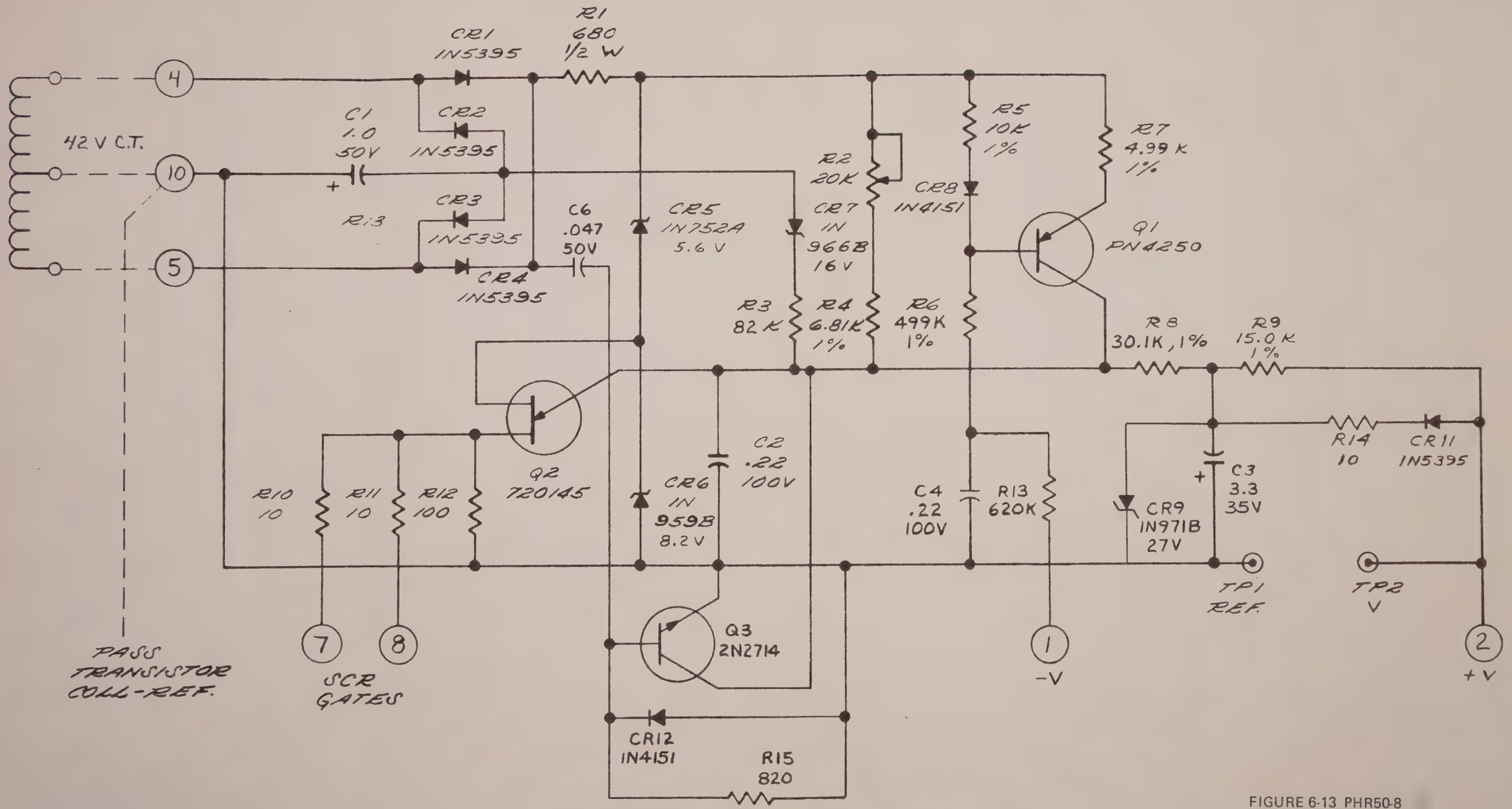


FIGURE 6-13 PHR50-8
A2, PRE-REGULATOR SCHEMATIC
7-06557602 Rev B

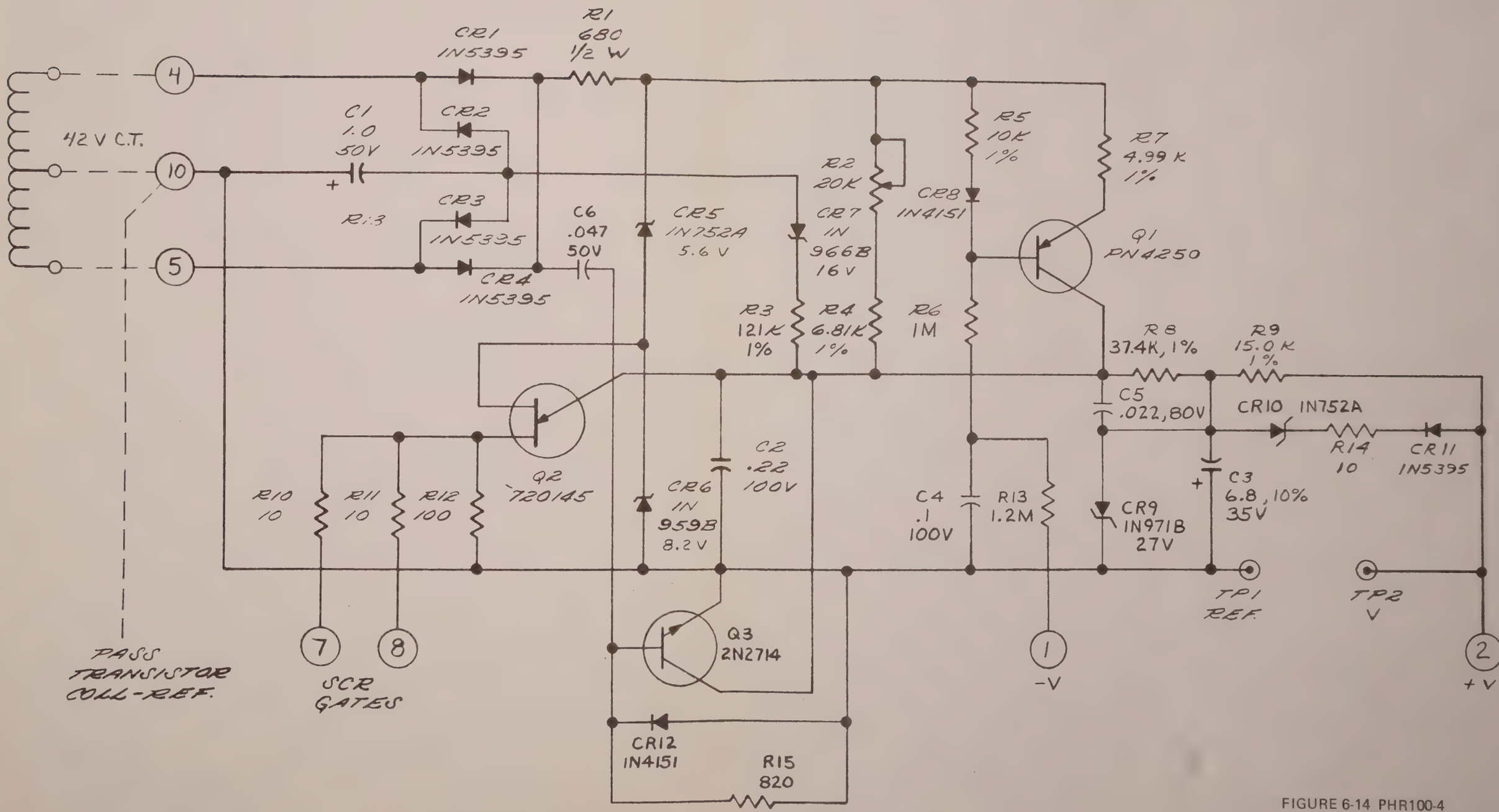


FIGURE 6-14 PHR100-4
A2, PRE-REGULATOR SCHEMATIC
7-06557603 Rev B

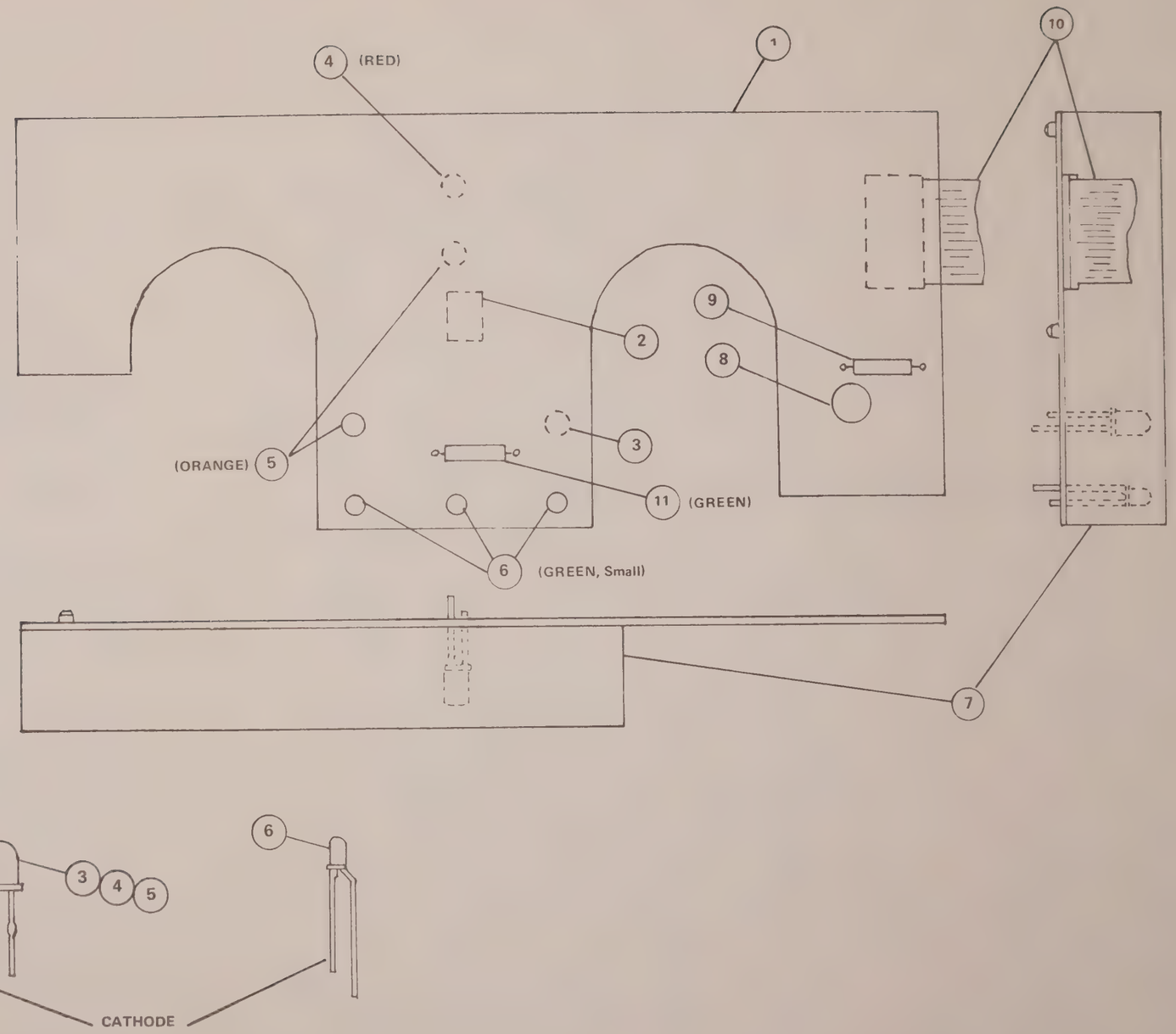
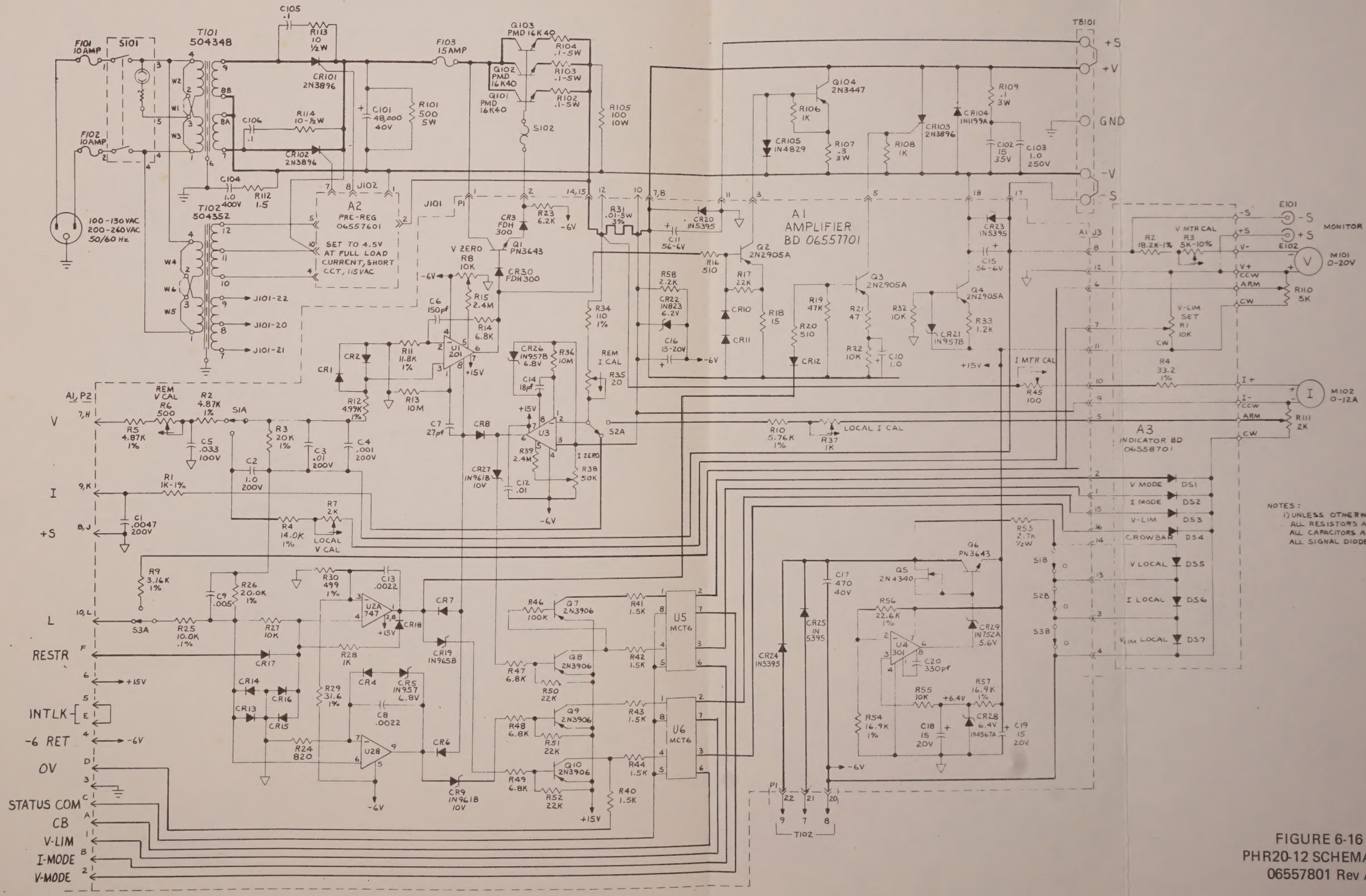


FIGURE 6-15 PHR SERIES
A3, INDICATOR PC ASSEMBLY
065587 Rev A



NOTES:
1) UNLESS OTHERWISE NOTED:
ALL RESISTORS ARE IN OHMS, ½W, 10%
ALL CAPACITORS ARE IN MICROFARADS
ALL SIGNAL DIODES ARE IN4151

FIGURE 6-16
PHR20-12 SCHEMATIC
06557801 Rev A

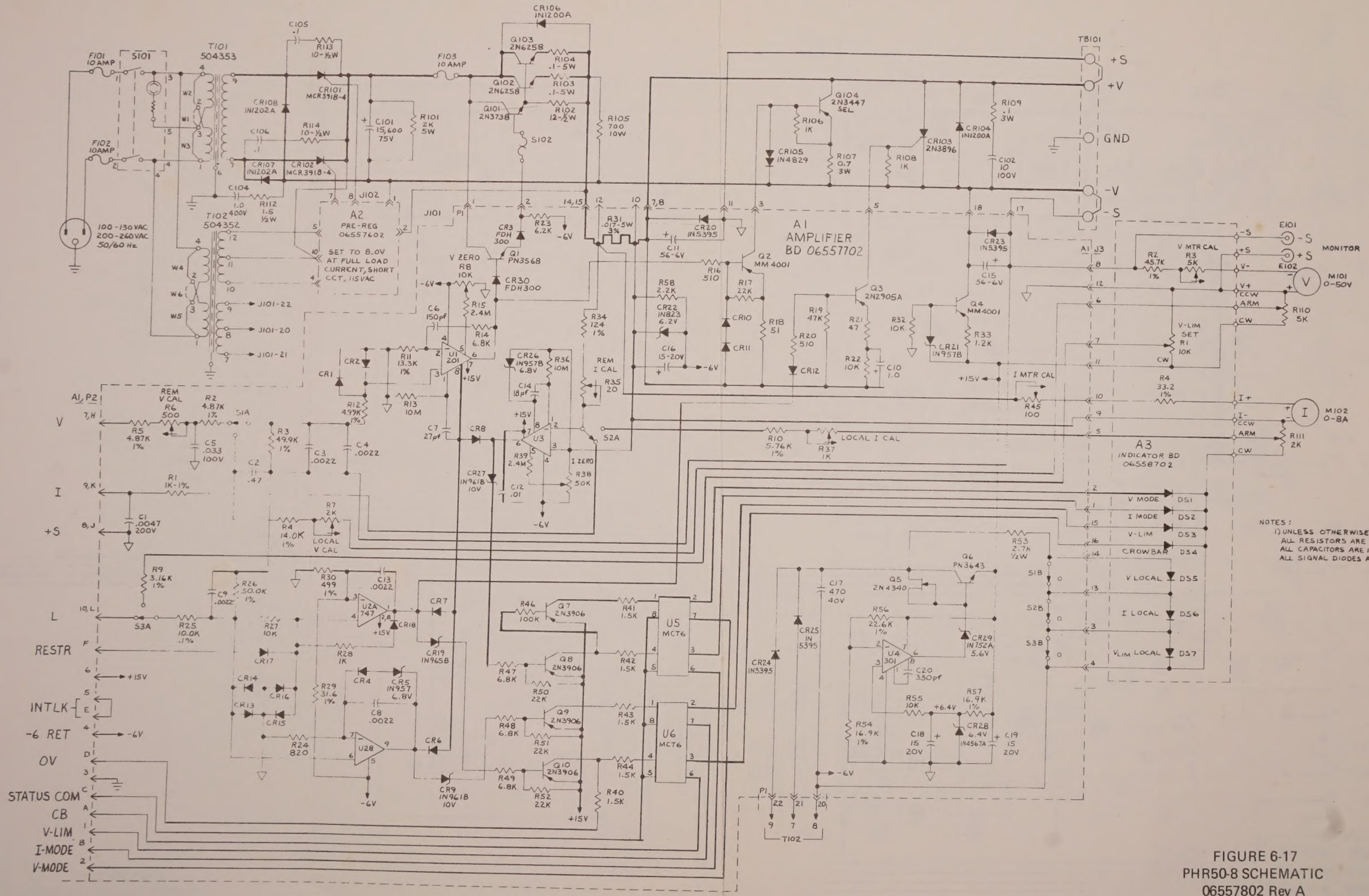


FIGURE 6-17
PHR50-8 SCHEMATIC
06557802 Rev A

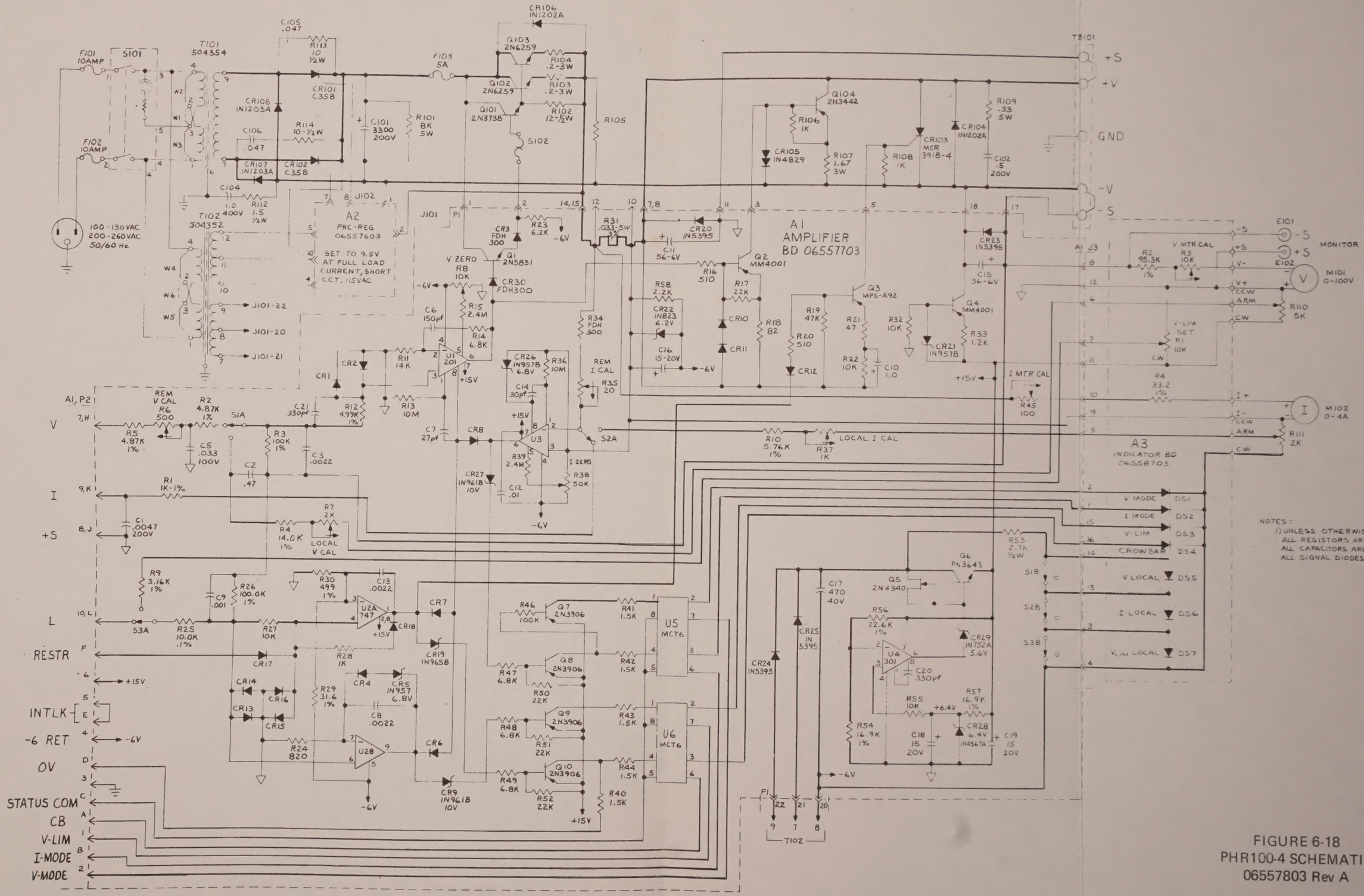


FIGURE 6-18
PHR100-4 SCHEMATIC
06557803 Rev A